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Fig. 1. Paneak, a Nunamiut man.

NOTES ON THE NUNAMIUT ESKIMO AND MAMMALS OF THE ANAKTUVUK PASS REGION, BROOKS RANGE, ALASKA

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THE Brooks Range, in northern Alaska, is biologically one of the least-known regions in North America. It has been during the last few years only that the use of light aircraft has made effective travel here possible. Since April 1949, I have made field observations in the Anaktuvuk Pass country, in the central part of the range; this work, the investigation of animal-borne disease, has necessitated a thorough study of the indigenous mammals. It is the purpose of this paper to record information of a biological nature on these mammals, with special emphasis on their relationship to the local Eskimo, the last remnant of the once numerous Nunamiut.[1]

The work has been carried out over a period of nearly three years and has of necessity been intermittent. I have made observations in all months except November and December, which are unfavourable for field work because of poor light conditions and lessened biological activity. Individual field trips have varied in length from ten days to nearly two months, and, in all, more than six months have been spent in this region. Several months have also been spent nearer the Arctic Coast, from Wainwright to Lake Schrader, where comparative observations have been made. In addition, Mr. E. L. Schiller, of the Arctic Health Research Center, and others, have contributed field observations.

After the first trips, because of transportation and supply problems, no camp was established and I lived among the Eskimo as one of them. This saved time by permitting more effective travel, but was particularly valuable in allowing greater insight into the lives of the people and an opportunity to learn something of their language.

Nunamiut words[2] have been included in this paper whenever it was thought appropriate. The difficulties in writing Eskimo words phonetically are well recognized. However, through considerable personal effort towards learning the Nunamiut dialect, and with the aid of an educated, bilingual Eskimo living with this group, it is believed that a high degree of accuracy has been achieved.

The work in the Brooks Range has been greatly facilitated by the generous cooperation of specialists in other fields of biology, by persons concerned with

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[1]*Nunamiut* ("people of the land") in this paper refers specifically to the Inland Eskimo formerly living from the Killik River to the Anaktuvuk River, but now existing as a small semi-nomadic group in the region of Anaktuvuk Pass.

[2]All Eskimo words have been written phonetically, except that certain sounds represented by the letter *g*, which do not occur in European languages, are not indicated, and *ch* following *a* or *o*, and the letter *i* represent the same sounds as in the German language.

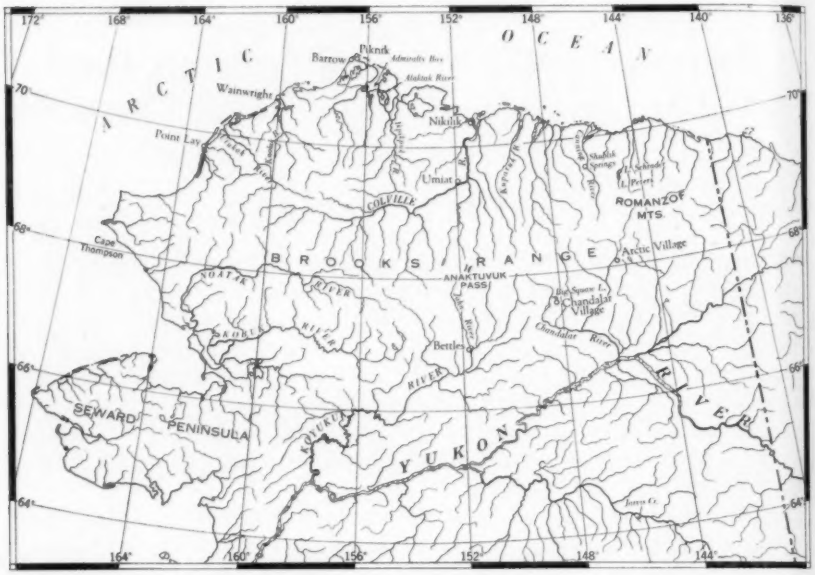

Fig. 2. Northern Alaska.

transportation and other necessary details, and, most important, by the Eskimo themselves. This opportunity is taken to express appreciation of this aid:—

Dr. Laurence Irving, former Scientific Director of the Arctic Research Laboratory at Point Barrow, with whom I first entered this region, deserves particular thanks. Professor George MacGinitie, who succeeded Dr. Irving at Point Barrow, contributed much to further the field work, and his efforts are much appreciated. The personnel of Naval Petroleum Reserve No. 4, at Point Barrow, and the Arctic Contractors, at Fairbanks, were very cooperative in arranging for transportation and supplies.

Mr. Thomas Brower and Mr. Clay Kaigilak, of Barrow Village, accompanied me on certain trips and their companionship contributed much to the enjoyment of the field work. Mr. Brower's intimate knowledge of arctic biology, especially of the local birds, was very helpful.

I was fortunate to spend a few weeks in the Brooks Range with Mr. Lloyd Spetzman, of the University of Minnesota, who has spent several field seasons studying the botany of the Arctic Slope and of the Brooks Range. His aid with plant identifications contributed much to my learning something of the botany of the region. Dr. George Llano, formerly of the Smithsonian Institution, identified the lichens, and Dr. William Steere, of Stanford University, identified the mosses.

The staff of the Division of Mammals, U.S. National Museum, made available every facility during two sessions of study there. Appreciation is expressed to Dr. Remington Kellogg, Dr. David H. Johnson, and Dr. Henry Setzer for valuable suggestions and generous cooperation. Thanks are also due to the U.S. Fish and Wildlife Service personnel at the National Museum, who permitted the use of the Biological Survey collections. Dr. R. M. Anderson, of the Canadian National Museum, allowed the comparison of the skulls of Brooks Range grizzlies with those collected by him farther east, and made helpful comments as to the relationships of these bears.

Fig. 3. Travelling north up the Anaktuvuk valley, just beyond the divide, 27 April 1949.

The Nunamiut Eskimo in particular have contributed to whatever success this work can claim. Not only did they do all within their power to assist me, but have made the time spent in their country an unforgettable experience through their hospitality and companionship. Mr. Homer Mekiana, a Point Barrow man who married a Nunamiut woman, and who has lived for many years among the Nunamiut, contributed greatly in several ways. Having been educated in the Point Barrow Native School, he was able to do much to clear up difficulties with the Nunamiut dialect. He has kindly checked the spelling of all Eskimo words given, and has read the manuscript for accuracy as to details of the life and customs of the Nunamiut. To Paneak, Maptigak, Inyualuruk, Kakinya, Ahgook, Ahkmalik, Pilala, Akurak, Ahngak, Aknaniak, and many others, go the best thanks for their aid in obtaining specimens, contributing observations, and, above all, for their excellent hospitality and friendship.

The biological interest of the Anaktuvuk Pass region is now widely recognized. Dr. Laurence Irving, of the Arctic Health Research Center, has studied the avian fauna for more than three years; Mr. Vladimir Walters, of New York University, has investigated the fishes, and Mr. Lloyd Spetzman and Dr. George Llano have made botanical studies. During the summer of 1951 numerous field parties entered this region, and it would seem that much valuable information on arctic biology will eventually be obtained.

I. The Country

My own field work has been centred in the vicinity of Tulugak Lake (68°20 N., 151°26 W.). Observations were made along the main valley of the Anaktuvuk and John rivers, from the north edge of the Brooks Range south

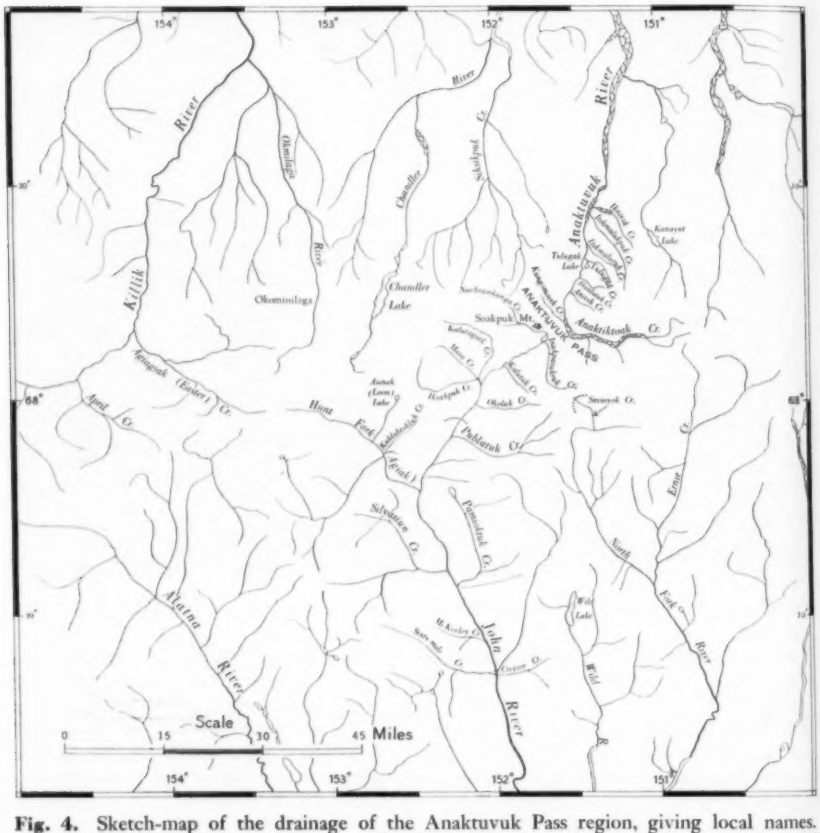

Fig. 4. Sketch-map of the drainage of the Anaktuvuk Pass region, giving local names. Dotted lines on the John River and on Savioyok Creek indicate the northern limits of spruce timber.

to Hunt Fork, a distance of about fifty miles. To the east, collections and observations have been made in the Savioyok valley, a part of the North Fork drainage of the Koyukuk; material and information were obtained from as far west as the Killik (*Kitlik*)[1] River.

Physiography

The mountains of the Brooks Range in the Anaktuvuk Pass region reach an altitude of from 6,000 to 7,000 feet and are composed mainly of Noatak Conglomerate overlain by Lisburne Limestone; geologically, they belong mainly to the Mississippian Age. These mountains, were apparently cut from a former plateau, and are much eroded.

Rocks outcrop in many places in the glacial till of the main valley through which meander the Anaktuvuk and John rivers. This broad valley (Figs. 3,

[1]Although the Eskimo name is *Kitlik*, the accepted map spelling is Killik.

5, and 9) forms a passage of two to four miles in width across the Brooks Range and is an important migration route for various mammals and birds as well as for the Eskimo. There are many glacial-moraine lakes, alluvial terraces, and ground moraines on the valley floor, which, at the divide, reaches an altitude of about 2,000 feet only. Sand dunes occur in places along the Anaktuvuk River. Numerous creeks, dry except during the spring thaw, tumble in steep, rocky beds from the mountains into the valley. The Anaktuvuk enters the main valley from the east, at an altitude of about 2,500 feet and flows northward to the Colville, which in turn empties into the Arctic Ocean. The part of the Anaktuvuk lying to the east of the main valley is called by the Nunamiut *Anaktiktoak*.

Brooks (1906, p. 102) has described the Anaktuvuk valley and pass: "This pass is only a few miles from where the range falls off to the piedmont plateau on the north, and the Anaktuvuk soon leaves the mountains. The intermontane part of its valley is wide, with abrupt walls, and is only about 15 miles in length, in which distance the river descends over 200 feet. Leaving the mountains, it enters a broad basin 40 miles in length, which has been incised in the Anaktuvuk Plateau and which receives several tributaries." Schrader (1904) has discussed several features of this country.

The John River enters the main valley from the west but a few miles south of the Anaktuvuk, and flows south to join the Koyukuk River, a tributary of the Yukon. The part of the John River which lies to the west of the main valley is called *Nachramkunga* (from genitive forms of *nachrach*, "divide", and *kook*, "creek") by the Nunamiut.

In the main valley certain springs and seepages remain open throughout the winter. Tulugak Lake is fed by such springs, which maintain a temperature slightly above freezing all year. Open creeks are also found in the winter in the Savioyok valley. There are no glaciers in the Anaktuvuk Pass region, but some snowfields persist all summer. There is a considerable area of *Aufeis*, or heavy ice deposits, in the Savioyok valley.

Climate

Although in the winter some days are made unpleasant by severe winds from the north (the Koyukuk Indian name for the lower John River is *Atchenak*, "blowing hard"), the region is not excessively cold. The temperature rarely falls as low as -50°F. The annual precipitation is only a few inches. The spring and summer weather are delightful, with cool, clear days. On approaching timber, farther south, the precipitation increases rapidly, resulting in deep winter snows. This is also the case in the timbered Savioyok valley to the east; the change in amount of precipitation is very striking as soon as the divide near the head of Inukpasukruk Creek has been crossed, at an altitude of about 4,500 feet, and the descent started into the country drained by the North Fork.

Since the generally sparse snow becomes firmly packed during the winter by the strong winds, the Anaktuvuk Pass country is very favourable for travel by dog team. Snowshoes are often unnecessary, unless approaching the

Fig. 5. Anaktuvuk valley, looking west, with Tulugak Lake in the foreground, June 1949.

timbered areas. In some places deep drifts are formed, but parts of the valley and many of the slopes are blown completely free of snow. The entire region is underlain by permanently frozen soil. In summer this thaws from a depth of several inches in the main valley floor to more than three feet in well-drained, gravelly places.

Vegetation

During the summer of 1949, Mr. Lloyd Spetzman generously aided me in determining the species composition of various plant communities. A detailed report on the plant ecology of the Brooks Range and the Arctic Slope will be published later by him. I have made plant collections whenever necessary, and am familiar with dominant species within the given communities. All names used in this paper are according to Hultén (1941-9).

The occurrence of three main biotic divisions within a relatively short distance makes this region unusually interesting from a faunal standpoint.

a) The *Arctic Slope Foothills* (wet arctic tundra) lie to the north only a short distance from Tulugak Lake. The vegetation here consists of tundra meadow plants, with some willow growth along watercourses. In some localities (e.g., Umiat on the Colville River), arborescent vegetation, mostly *Alnus crispa* (Ait.) and *Salix* spp., becomes dense and luxuriant, but this is of rare occurrence so far north.

b) *Arctic Mountains* (dry alpine tundra). From just north of Tulugak Lake south to the limit of spruce timber, a distance of about forty miles, a variety of plant communities occurs.

The vegetation of the main valley consists of tundra species, with sedges predominating. These include *Carex Bigelowii* Torr. et Schwein., *C. aquatilis* Wahlenb., and *Eriophorum* spp. Typical heath-moors occur where the soil is drier; pre-

Fig. 6. Springs at the south end of Tulugak Lake, late May 1949.

dominant species here are *Cassiope tetragona* (L.), *Ledum palustre* var. *decumbens* Ait., *Rhododendron lapponicum* (L.) Wahlenb., *Empetrum nigrum* L., and *Vaccinium Vitis-idaea* L.

The river and creek banks are covered by heavy stands of willow, including, among others, *Salix alaxensis* Cov., *S. Richardsonii* Hook., *S. arbusculoides* Ands., and *S. arctica* Pall., with a varied undergrowth of *Equisetum* spp., mosses, and lichens. Birch–willow communities of *Salix* spp. and *Betula nana* L., with undergrowths of mosses and lichens, occur in drier habitats.

The dry, rocky mountain slopes support little vegetation other than *Dryas octopetala* L., which also occurs on moraines and alluvial fans. South-facing slopes are covered with *Dryas*, with other species interspersed, while the north slopes support a *Cassiope*–lichen community, in which *Cladonia* spp. are important. *Therofon Richardsonii* (Hook.) is a very common plant of moist drainage areas, usually associated with various mosses. The higher peaks are barren.

Solifluction terraces in the mountains support a dense growth of vegetation. In such places occur *Salix* spp., *Dryas octopetala*, *Potentilla biflora* Willd., *Poa glauca* Vahl, *P. pratensis* L., *Carex scirpoidea* Michx., *C. Bigelowii*, *Kobresia simpliciuscula* (Wahlenb.), and *Polygonum viviparum* L., among others. Earth-surface movements, which are important in the region, have been discussed by Troll (1944).

Sedge-bogs are found in and around semi-permanent shallow pools of water in favourable places at altitudes to about 3,000 feet. Characteristic plants are *Equisetum pratense* Ehrh., *E. variegatum* Schleich., *Carex aquatilis*, *C. membranacea* Hook., and *Eriophorum angustifolium* Honckeny.

In some areas the lower hillsides are covered by tussock ("niggerhead") tundra, the predominant plant being *Eriophorum vaginatum spissum* (Fern.). Local, often pure, stands of various plant species occur, including *Alnus crispa*, and *Populus tacamahacca* Mill., none of which is large enough to be important.

Mosses form an important part of the plant community in almost every habitat. *Rhytidium rugosum* (Hedw.) (*ivrok*, "roof moss") grows around marshy areas, in

somewhat higher places, forming a dense cover, and is often associated with *Dryas*, *Salix* spp., and lichens. It is found in moist areas to about 3,500 feet on the mountain sides. In certain areas, particularly around the flowing springs near Tulugak Lake (Fig. 6), *Hylocomium splendens* (Hedw.) forms the greatest part of the ground cover; it is often found under *Salix arbusculoides*. *Dicranum elongatum* Schleich. (*iparok*, "wick moss") grows commonly around willows, forming hummocks, and is found in the main valley in the drier areas. *Sphagnum rubellum* Wils. occurs in various places, but is not abundant. *Philonotis fontana* (Hedw.), *Pohlia Wahlenbergii* (Web. and Mohr), and *Cratoneuron filicinum* (Hedw.) grow in wet areas along the flowing springs, and are often semi-submerged.

c) *South Slope of Brooks Range* (spruce forest). Just north of Publatuk Creek, in the main valley, the spruce timber, *Picea glauca* (Moench), begins. Balsam poplar and birch, *Betula resinifera* Britton, occur here; the first birch is found near the mouth of Publatuk Creek. This is the typical upland spruce forest of interior Alaska. To the south, spruce trees gradually occur at higher altitudes, and the forest acquires an even density. In the vicinity of Crevice Creek, the north-facing slopes support little or no spruce, although all south-facing slopes are densely covered.

A heavy spruce stand is found in the Savioyok valley (Figs. 7 and 8), representing the northernmost extension of the species in the region. Here there are trees with a base diameter of as much as 24 inches. *Salix alaxensis* reaches a height of about 20 feet, and other species of willow form dense stands in the river bottom. Alder is abundant, balsam poplars occur in small numbers, but *Betula resinifera* is absent.

These various plant communities will be mentioned specifically, later, in connection with the habitats of certain mammals. Mammals and birds from both tundra and forest are observed from time to time in the northern mountain region. This allows unusual possibilities in the number of species of mammals that may be found. Irving (MS.) has discussed some of the ornithological features of this region.

II. The People

The local Eskimo are nomadic caribou hunters, who call themselves *Nunamiut*; this name, in their own dialect, means "people of the land", and corresponds to Nunatarmiut (Larsen and Rainey, 1948), and to Nunatagmiut (Stefansson, 1914). Larsen and Rainey in 1948 (p. 24) reported that the Nunatarmiut had long ago abandoned the region to the north of the Brooks Range. However, Solecki (1950) pointed out that a small group of these people survived in this region, and at the same time summarized from the literature all available information concerning them. On the other hand, the existence of these Inland People was never lost sight of by the coastal Eskimo, particularly at Wainwright and Barrow, and by others acquainted with the Brooks Range region.

While it is true that very few of the Inland People survive in their ancestral hunting grounds, a single group of 71 people still remains. There are 12 separate families, but in 2 the mother is no longer living. There are 8 unmarried girls (including one widowed at 22 years of age), 6 unmarried young men, and 34 children. There is also one unmarried woman of about 40 years.

I was present in the summer of 1949 when the Killik River segment of this group joined the others at Tulugak Lake. They came because of better trade facilities, and because of the hope that their children could be taught English.

Fig. 7. Last of timber in the Savioyok valley, 3 April 1950.

Fig. 8. Savioyok valley, looking north, April 1950.

Fig. 9. Mekiana hunting for sheep, looking east across the Anaktuvuk valley, near the mouth of Kungomovik Creek, 3 October 1950.

At that time, except for the use of firearms, these people apparently lived as they had done for centuries. They knew no English and existed almost exclusively by hunting. Since 1949 these Eskimo have undergone a very marked change in their way of living. Although still nomadic, and still largely dependent on hunting, they are gradually becoming adapted to the white man's economy. In the spring of 1951 a post office, ensuring regular monthly mail deliveries, was established at Anaktuvuk Pass. This is the first tangible connection these people have had with the "outside world", except for occasional transient traders. Further, the establishment of this post office tends to localize the people, and this has a strong effect in reducing their nomadic hunting. Although no school has been established as yet, several of the people have made rapid progress toward learning English.

It is known that the Nunamiut differ physically from the coastal Eskimo. They are often tall, and have narrower faces with a thinner, high-bridged nose (Fig. 1). In general their facial features are less mongoloid than those of the coastal Eskimo. Seltzer (1933, p. 347) concluded that their physical features "clearly betray the presence of considerable Indian blood that must have entered this group in comparatively recent times." Larsen and Rainey (1948, p. 36), on the other hand, stated that: "We do not know whether the physical type of the Nunatarmiut has been influenced by contact with the Indians or whether the tall lean Nunatarmiut, with the narrow face and the long, high-bridged nose, was originally different from the coast Eskimo." I have been told by these people that in the old days the Nunamiut men would occasionally take an Indian wife, but that the reverse was never true. The Nunamiut consider themselves to be superior to the Indians, with whom they formerly had frequent conflicts. In any case, the Nunamiut are a fine physical type, well suited to their mountaineer–hunter existence.

The present-day Nunamiut are a cheerful, hardy people, reserved in the presence of strangers, but demonstrative enough among themselves. They stoically endure pain and hardship, but the capacity for great depth of feeling cannot be doubted by anyone who knows them well. The words of some of their songs indicate unusual aesthetic appreciation of the natural beauty about them. Since they have had relatively little contact with the white man, they largely retain the virtue of honesty, and often cache their most valuable belongings for several months of the year without fear of theft. They have no community organization; each man is on a level with every other. The women apparently have a position equal to that of the men, and the family unit is very strong.

Large families are the rule, and the birth rate is high. A high rate of mortality may result when there is an outbreak of some "white man's disease", such as measles or whooping-cough. During the last three years, there have been eight deaths: two young men died of pneumonia following influenza, two infants died of whooping-cough, two children of dysentery caused by *Shigella paradysenteriae*, and two children from unknown causes. The people have so far escaped the ravages of tuberculosis, which has had such a disastrous effect in coastal Eskimo villages. The incidence of positive reactors to the

Fig. 9. Mekiana hunting for sheep, looking east across the Anaktuvuk valley, near the mouth of Kungomovik Creek, 3 October 1950.

intradermal tuberculin test is extremely low[1]—in fact, one of the lowest to be found in Alaskan native communities. However, if the Nunamiut abandon their present active outdoor life, this disease may well become prevalent among them also.

Historical Information

The *Nunamiut* know themselves to have been for some generations inhabitants of the central Brooks Range, from the region of the Anaktuvuk to the Killik, and they can point out where certain of their ancestors were born in the valleys they now inhabit.

Many years ago, when they were numerous and widely dispersed, they designated themselves according to the region in which they lived and hunted. Thus, there were three main groups: the *Tulugakmiut* (*tulugak*, "raven")—the people living in the vicinity of Tulugak Lake; the *Narivakvukmiut* (*narivakvuk*, "big lake", Chandler Lake)—the people living near Chandler Lake; and the *Kitlikmiut*—the people living near the Killik River.

The Nunamiut made definite seasonal migrations, connected with their hunting and trade with the coastal Eskimo. Formerly, the Tulugakmiut would go by dog team in May to the mouth of the Anaktuvuk River, where they had cached their skin boats (*umiat*) the previous autumn. Here they left their sleds, and after break-up took their dogs and other possessions, and travelled to the mouth of the Colville River, to a place called *Nikilik* (from *Nikilivik*, "white-fronted goose"), the *Nirlik* of Stefansson (1914). At Nikilik they were met by Point Barrow people, who came for the purpose of trading. In this way they obtained seal oil and seal skins, and later, articles which the coast people had traded from the whalers. In August they returned to the mouth of the Anaktuvuk, hunted and fished until freeze-up, and then returned to the mountains to spend the winter in hunting.

Schrader (1904, p. 35) considered Nikilik an important settlement. Stefansson (1913; 1914) met some of the Inland People at Nikilik. The grandchildren of one of the more prominent of the Inland men, Pannioluk, mentioned frequently by Stefansson, are among the remaining Nunamiut in the Brooks Range. One of these, a young woman of twenty-four, also bears the name Pannioluk.

The Kitlikmiut cached their skin boats at the head of the Ikpikpuk, to which they portaged from the mouth of the Killik. In the spring they travelled to the neighbourhood of Barrow (*Otkiavik*, "place of owls")[2] to trade. They usually camped near the duck-hunting station, *Piknik*, east of Barrow Village. Late in summer they returned south and came back to the Killik after freeze-up. I do not know which route was taken by the Narivakvukmiut.

Winters were spent in hunting, and the Nunamiut moved according to the caribou migrations, never staying long in one place. The Kobuk people

[1]This test was administered by Dr. Wendell C. Mathews, Tuberculosis Consultant, Alaska Department of Health, and myself during early September 1951. At this time we vaccinated all non-reactors against tuberculosis by the BCG method.

[2]According to Mr. David Brower, of Barrow Village, this name is correctly *Okpiæ̈vik* (from *okpik*, "snowy owl", and *vik*, "place"), but was changed to the present form during his father's time.

from the south occasionally came to Hunt Fork for trading, or even as far north as Kungomovik Creek (*Kungomovik*, "gathering place"), just above the head of Anaktuvuk River. The Kobuk people were mainly interested in obtaining sinews and winter caribou skins. They brought the first white man's food to the Nunamiut. Guns were obtained by trading long before there was any direct contact with the white man.

The present-day Nunamiut follow essentially the old ways, but they no longer make the seasonal journeys to the coast for the purpose of trading, since modern transportation has made available to them such things as they are able to purchase. The summer months are spent in a relatively permanent camp; that is, the people camp in a general area, but the tents are moved a short distance every few weeks in order to ensure sanitary surroundings. During the summer, aside from the necessary hunting and fishing, the men overhaul equipment and make preparations for the coming winter. Dances are often held, particularly when there is unusual success in hunting, or on some other special occasion. For these dances, two large drums are used, three to four drummers at each. The style of dancing is similar to that seen along the Arctic Coast.

The winter is considered the best time of the year. The people do not, as reported by Solecki (1950), winter in the Koyukuk River village of Bettles, but travel widely in search of game. They are excellent hunters, and the wolf-bounty is their most important source of cash income. Wolf skins are sold also to the coast people, who are unable to obtain sufficient wolves for parkas.

Dwellings

The typical Nunamiut dwelling is a portable structure made of caribou hides stretched over a willow frame. The willows are obtained from the south, where they grow tall and slender. This type of house is called *itchelik* (from *itchet*, "hide used for cover") or *kalukvik*, referring to the frame (Fig. 10). It has a round to oval base, usually about twelve feet in diameter, with the highest point of the ceiling five or six feet above the floor. The house frame has a standard structure. The four main sticks, two on each side, and the first to be placed in position when the *itchelik* is being erected, are called *tupkotat*. The two sticks framing the door are called *palitchut*. The middle sticks, one from each side, running between the *tupkotat*, are *kanagoat*, as are all others running from side to side. All sticks running from the back are *kilusiat*, and all from the front, with exception of the above-mentioned *palitchut*, are called *salichat*. The thongs binding the sticks together are called *kiligotit*, while those holding the *talu* ("door-flap") in place are *taluliutut*.

About twenty caribou hides are required to cover such a house. Six hides, sewn together in a strip called *itchet*, are used for the roof. Two strips, of three skins each, called *siaktalat*, are used for the back, and a strip consisting of two skins, *maloagaluk*, is used on each side. To the right of the door, in front of the stove or fireplace, a single strip, *sakutak*, is placed. These hides, like most skins used for clothing, are prepared by thorough scraping only. This gives them pliability and they may last for as long as three years as house

covers. Skins are placed on the frame with the hair-side out. A second cover, now made of canvas, but formerly made of hides from which the hair had been removed, is used to make the structure waterproof. The floor covering in all types of Nunamiut dwelling is of willow branches covered in part with hides. The hide of a grizzly bear is preferred for the door-flap (*talu*), and this is hung with the fur-side in, but a heavy bull caribou hide is sometimes used. The window (*igalik*) is often made from strips of the small intestine of the grizzly bear, cleaned and sewn together to form a sheet. In

Fig. 10. Nunamiut *itchelik*, Anaktuvuk Pass, with drying caribou meat in the background, May 1950.

the old days, two caribou skins, from which the hair had been removed by soaking in water, were used.

Solecki (1950, p. 145) described the *itchelik*, but quoted various authors to the effect that several inches of snow were packed over the outside covering for added warmth. Such houses are already very warm, and I have never seen nor heard of snow being added for insulation. I know nothing of the multiple-family house reported by Stoney (1900) in this region.

The *itchelik* was formerly occupied the entire year regardless of weather conditions; most of the people now live in canvas tents during the summer.

Another type of house, of sod placed over a wooden frame, is sometimes built when the stay in a place is longer. This house, called *ivrulik*, referred to by Larsen and Rainey (1948, p. 35), is uncommon.

Clothing

Most of the Nunamiut now wear white man's clothing, especially during the summer months. However, the more essential items of clothing for winter

wear are made of caribou hide, which for real warmth is superior to anything else available. Caribou hides require little preparation for use as clothing. When the hides are removed, they are spread on the ground to dry. In the summer and fall, when most of the caribou are killed, drying is very rapid and the dried skins can be cached until needed. The hides are then thoroughly scraped, thus removing the superficial layers and breaking down the fibres to give softness. For most purposes the soft, white leather prepared requires no further treatment. If a better grade of leather is needed, the hides are smeared with a mixture of brains boiled in water, or a paste of liver, and rolled up in a warm place over night. The following day the hides are scraped until gradually dried, and this results in a very fine, soft leather. A white clay, called *kitik*, was formerly used for softening hides. It was obtained from a place of the same name on the Colville River below Umiat. All sewing is done with caribou sinew, and the necessity of saving the long back-sinew has resulted in the development by the Eskimo of a highly standardized method of cutting up these animals.

Boots are made of caribou hide, and there are several styles, depending on season and use. For winter the soles are made of thick neck-hide of fall-killed bulls, with the hair turned in. Inside parkas are made of cow or fawn skin; a heavier outside parka is worn with the hair-side out during the winter. Parka ruffs are made either of wolf or of wolverine fur, with the former being perhaps the more common, particularly with the men. The hides of sheep are used for parka trimming, and when caribou are scarce may be used for clothing. They make the best sleeping bags.

Food

Although certain food items, such as tea, flour, and sugar are now obtained from the white man, the Nunamiut diet is essentially unchanged from that of many years ago. Frozen fish are frequently eaten in the fall and, when they can be obtained, in the spring. Meat forms the great bulk of the diet and the caribou is the main food animal, upon which the Nunamiut depend for survival. Much caribou meat is dried, in both spring and fall, for use when hunting is poor. A considerable amount of meat is eaten raw or raw and frozen, particularly when on the trail. All animals killed are very completely consumed. Cooked heads of sheep are considered unusually good. The brains (*kakisalik*) are eaten cooked or raw and frozen. The ligamentum (*kauksik*) at the base of the skull is eaten raw, at the time the sheep is killed, for its high fat content. The interdigital glands (*akunigun*) are always eaten raw, and the testicles of rams are cooked. In the old days the women were not permitted to eat any meat forward from the last three or four ribs of sheep or from the front of the hind leg, nor could they eat fat from the body cavity. These customs no longer persist.

Long-bones of caribou and sheep are cracked for the marrow, but are not as completely utilized as they once were, when even the ends were rendered out by boiling. In the fall every effort is made to procure a good supply of caribou rump-fat. In May, whenever caribou are skinned, the larvae of the caribou warble fly, which have reached their greatest size prior to pupation,

are eaten by the Nunamiut. These larvae are often found in large numbers lying just below the skin on the back, and are eaten alive as they are removed from the small pocket of inflammatory tissue surrounding them. I have found these larvae quite palatable.

Cooking, which has become a more common practice in later years, is done on small sheet-metal stoves. Maptigak, now an old man of about seventy years, stated that he was "old enough to hunt ptarmigan" before his family had any stove other than the old fireplace (*sinigun*) outlined by a few stones on the floor. Cooking was done then in wooden vessels by adding heated stones.

Larsen and Rainey (1948, p. 31), in discussing the "Nunatarmiut", stated that: "When, for some unexplainable reason, the caribou fail to appear in numbers sufficient for their needs, the Nunatarmiut had the choice of starving or of settling on the coast until the herds returned." This hardly appears to have been the case, since then, as now, they were capable of obtaining other animals in large enough quantity for survival. During the times of caribou shortage, the people eat ground squirrels, marmots, sheep, and fish. Bears are obtained from time to time, but never make up a very important part of the diet. When caribou are exceptionally scarce, the people may move to timbered regions where moose can be obtained in adequate numbers. The abundance of mammal life in the Brooks Range seems to ensure plentiful food, unless hunting success is prevented by a combination of unfavourable circumstances.

Transportation

The present-day Nunamiut have fine teams of unusually large and powerful dogs, some of which weigh more than 100 pounds. The Nunamiut have at times been criticized, by those unfamiliar with the conditions, for keeping large numbers of dogs, which naturally require a considerable amount of meat. However, large teams are needed to transport loads over terrain as difficult for dog team travel as that of the Brooks Range outside the main valleys. On one trip over the mountains to the east, which I made with one of the Eskimo, we used ten dogs though we had almost no load, and sledding conditions were at their best. On fairly level ground, as in the main valley, about 100 pounds per dog is considered a suitable load. During the summer months, in the fall before freeze-up, and often on hunting trips in rough terrain, the dogs are used as pack animals. They are capable of carrying very heavy loads in pouches on either side of a caribou-hide pack saddle. I have seen a dog carry the entire fresh hide of an adult bull moose for a distance of more than two miles without showing undue signs of fatigue. Another dog carried a bear hide, which weighed slightly over 50 pounds, about ten miles through new snow, the bottoms of both pouches dragging deeply the entire distance.

The Nunamiut sled has runners made of spruce, from trees obtained in the timbered regions to the south or to the east. A tree which has a pronounced curve just beneath the ground surface is felled and sawn lengthwise into boards. An entire section, after some shaping, is used for a runner, the bent end making the curved front.

In the old days, spruce was obtained for umiak and kayak frames from the North Fork River valley. The journey for wood was made up the Anaktiktoak, and the round trip from Tulugak Lake required but two days. The frame of the umiak was covered with bearded seal hide, obtained through trade with the coast Eskimo. Kayak frames are covered with caribou hide. The umiak is not now used, but kayaks are used from time to time, particularly for spearing swimming caribou.

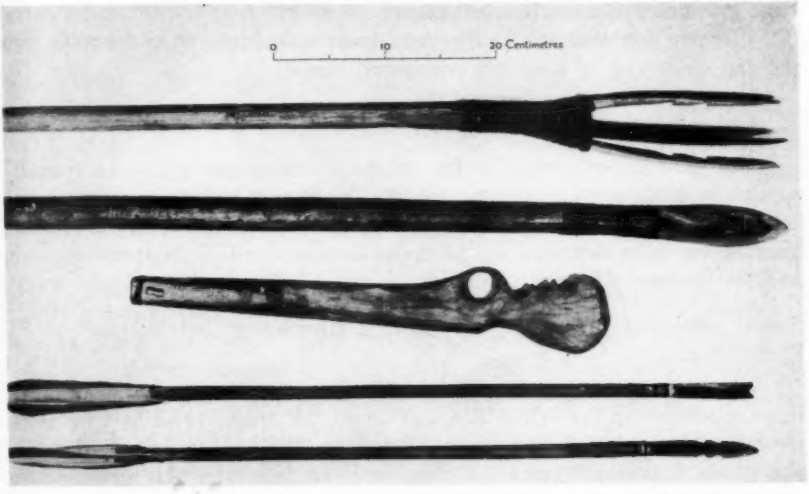

Fig. 11. Nunamiut weapons: three-pronged throwing spear; spear for swimming caribou; throwing stick; bird arrow (*uchulik*); caribou arrow (*natkulik*).

Hunting Implements

The main weapon of the Nunamiut was the bow and arrow. Bows were of two kinds: one backed with sinew (*piralik*), and one without sinew backing (*kiluinak*). Certain twigless spruce branches, called *ikik*, were preferred for making bows. Arrows (see Fig. 11) were preferably made of birch, but spruce was sometimes used. Arrows were of three kinds: a barbed one, for larger animals, particularly caribou, called *natkulik*; one with two blunt points, for birds, called *uchulik*; and another with three blunt points, also for birds, called *kukulvalik*. Arrow points were usually made of caribou horn. Bows and arrows were stained with a bog-iron ore, called *ivisak*, from a place of the same name on the Killik River. The stain imparts a brick-red colour, and is still used for colouring the wood of snowshoes, sled runners, and other wooden implements. Molting waterfowl were captured by means of a three-pronged spear, thrown with a throwing stick (Fig. 11).

Firearms were secured through trade long before there was direct contact with the white man. Flintlocks were obtained first, followed by guns fired by percussion caps, then the rim-fire .44, and later the centre-fire .44. I have

found .44 rim-fire shells, along with fragments of caribou bones, a few inches beneath the surface of the ground, in old campsites. Several calibres next appeared, including .45-70, .38-70, and .38-55. The latter is said to have been first obtained in 1908 at Nikilik from the people of Barrow.

The most popular gun today is the Winchester model 94 in .30-30 calibre. Also used are the .25-35 and the .25-20. A few men have recently obtained guns of .257 calibre, which allow much greater success in wolf hunting because of the longer range. The Nunamiut shoot well, and do not hesitate to kill large grizzlies with rifles of small calibre.

Hunting methods will be discussed more specifically in connection with the various species of mammals considered below.

III. Brooks Range Mammals

The observations made so far on the mammals are presented here by species, according to systematic order. Nunamiut species-names and any others considered appropriate are included. All prepared mammalogical material has been deposited in the collections of the U.S. National Museum and the National Museum of Canada.

Sorex obscurus obscurus Merriam. *Ugruknak* ("like bearded seal"). Dusky shrew.

About 50 specimens were obtained of this shrew, the most common of the three species collected in the Brooks Range. Of these, 14 skins with skulls were deposited in the U.S. National Museum in 1950; another series of similar size has been prepared since that time, and the remainder was autopsied for parasites only. *Sorex obscurus* seemed particularly abundant around the springs at Tulugak Lake. Here it was trapped at small burrows in the mosses *Philonotis fontana* and *Pohlia Wahlenbergii* along the water's edge. It was also obtained in vole sets on higher ground in the same area. Specimens of this shrew were collected in the main valley, but not above an altitude of 2,100 feet; however 9 were trapped in spruce timber in the Savioyok valley at an altitude of about 2,500 feet, and 4 were taken on upper Hunt Fork.

Few observations were made on the breeding of this animal. In 1949 a female containing two embryos was collected on June 1, and one containing nine embryos on July 26; a lactating female was taken on July 12.

The molt into winter pelage occurs during September in this region and September specimens show much variation in the molt pattern.

Tracks of shrews are often seen in the winter around wolf-kills and other carcasses, but it was not determined if all species of shrews feed in this manner.

Sorex cinereus ?ugyunak Anderson and Rand. *Ugruknak*. Arctic cinereous shrew.

On the basis of the first material collected, the cinereous shrew of the Tulugak Lake region and of Umiat was assigned to this form. Anderson and Rand (1945) also assigned two specimens from the eastern Brooks Range to the subspecies *ugyunak*. After adequate series are obtained, and when com-

parative material is at hand, restudy of my material will perhaps be justifiable in order certainly to determine the subspecific status of this central Brooks Range form.

The cinereous shrew was not commonly collected, but a good series was taken near the divide between the Anaktuvuk and John rivers. A single specimen was collected at Kanayut Lake. This shrew appears to prefer a somewhat drier habitat than does *S. obscurus* and was taken in higher areas where there was a heavy moss cover beneath willow and dwarf birch. Eleven specimens were obtained near the last spruce timber in the upper Savioyok valley. *Sorex cinereus* is the smallest of the three species collected.

Sorex tundrensis Merriam. *Ugruknak.* Tundra saddle-backed shrew.

Tundra saddle-backed shrews seemed to be about as common as *S. cinereus*, and were collected in the same kind of habitat. One specimen was taken at Tulugak Lake, and one on Itikmalukpuk Creek, but the others were obtained from farther south, on higher ground. None was collected in the timbered country. The animals preserved are in winter pelage.

This species is known to occur on both sides of the Brooks Range (Hall, 1929), but in some years, at least, it must be uncommon. In spite of intensive trapping during 1949, no specimen was obtained, either in the Brooks Range or as far north as Umiat, or along the Arctic Coast.

Of 16 shrews collected during October 1950, near the head of the John River, in the main valley, 7 were *S. cinereus*; 7, *S. tundrensis*; and 2, *S. obscurus*.

Ursus richardsoni Swainson. *Achlach.* Arctic grizzly.

The arctic grizzly (Fig. 12) is one of the most interesting of the Brooks Range mammals. It is not often seen, since it seems to spend much of the day sleeping high on the rocky mountain sides, and is frightened from the vicinity of Eskimo camps by the howling of the dogs. It is often hunted, which contributes to its wariness.

This animal is widely distributed, and in Alaska its range appears to encompass at least the entire region north of the southern limits of the Brooks Range, including the Arctic Slope. According to Thomas Brower, it is not unusual to see grizzlies at his reindeer ranch on the Alaktak River, near Admiralty Bay; an adult male was killed there in 1949, and three others were seen together early the same spring. I have examined skins from the Kaolak River, about fifty miles southeast of Wainwright, and from the Utukok River, about ninety miles southwest of Wainwright. A young male, about three years old, was shot at Oumalik, on the Arctic Slope, and these bears were not uncommon around Umiat, on the Colville River. The skull of a young animal was obtained from Mr. Lloyd Spetzman who had shot it near Shublik Springs in the Canning River valley. Stefansson and Anderson (1913) collected this bear in northern Alaska, but did not consider it common north of the Brooks Range.

The winter den is usually excavated high in the mountains, but some of these bears also winter on the Arctic Slope. I saw a den, from which a bear had just emerged, near the top of a bluff along the Colville River near Umiat.

The Nunamiut name for the winter den of bears is *sidroak*. According to the Inland People, the bears come to the mountains in the fall to den, and move north to the Arctic Slope in the spring.

The bears often enter the dens very late, and some individuals not at all. I collected an old male on 15 October 1950, in heavy snow in the Savioyok valley, and an aged male was killed in the same locality on November 9. The Eskimo saw bear tracks on Ikiakpuk Creek on November 18, and the track of a large bear moving south along the upper North Fork near the end of

Fig. 12. Grizzly bear, Savioyok valley, 15 October 1950.

November. Tracks are commonly seen in November, but all the bears remaining out appear to be males. In this respect they are perhaps similar to the polar bear. Paneak told me of killing a large male bear on 18 December 1945, near the head of Hunt Fork. The animal was fat and in good condition, but, according to Paneak, all four feet had been frozen, resulting in hair loss. Bears killed in the winter usually have much ice in their fur. In former times the Nunamiut believed that grizzlies would deliberately enter an open spring in winter, allowing water to freeze in their coat in order to retain warmth.

As reported by A. Murie (1944) for *Ursus toklat* Merriam, the arctic grizzly emerges from its den in April. In 1949 the first bear was killed by the Eskimo on May 6. On 3 April 1950 I saw the tracks of three different bears in the Savioyok valley; these had been made by an old female with a cub, and by what was apparently a yearling cub. The same day the tracks of a large adult were seen by the Eskimo in Okoluk Creek. In 1951 the first tracks

were seen on April 13. There is very little food available at this time of the year, for conditions are still very wintry.

For several days after emergence the bears remain around their dens, sometimes returning to them. In this region they feed largely on old wolf-kills or other carcasses. The Eskimo reported that they had seen a bear, during the month of April, trying to dig a wolverine from a burrow in the snow, but it easily escaped. The bears are in poorest condition in June, although many berries from the previous year, and many roots, are available. In July, as vegetation becomes more abundant, they improve in condition.

The feeding habits of *Ursus richardsoni* compare well with those of *U. toklat*, as reported by A. Murie (1944). There is no evidence, in spite of the common occurrence of caribou hair in bear droppings, that these animals kill any caribou. It is possible that a few fawns are killed in the spring, but this is unlikely as the fawns are born on the Arctic Slope, where bear density is not great.

No particular effort has been made to collect bear droppings for studies of food habits, but a few incidental observations have been made. During the summer the arctic grizzly is almost entirely a vegetarian, as little animal matter can be obtained unless a carcass or wounded animal is found. The stomach of a bear killed on 19 July 1949 contained a quantity of *Equisetum* sp. and some caribou hair. *Therofon Richardsonii* (=*Boykinia Richardsonii*), which is common in the Brooks Range, is often eaten, particularly the roots. In the fall I have sometimes seen droppings composed almost entirely of cranberries (*Vaccinium Vitis-idaea* L.), and numerous excavations can be found in creek beds and on sand bars where bears have dug for the roots of *Hedysarum* sp. These roots, which are abundant, are often eaten by the Eskimo, who call them *masu*. Voles (mainly *Microtus miurus*) were numerous during the time of this study, and large areas were frequently seen where bears had torn away the moss in their search for these rodents. Ground squirrels are dug out, especially in the fall, and ground squirrel hair is often seen in bear feces. The stomach of a bear shot at Oumalik on 20 July 1949 contained four lemmings (*Lemmus trimucronatus*), the digital bones of either an adult caribou or reindeer, and a considerable quantity of *Carex* sp. This animal was killed shortly after a heavy mortality of lemmings along the Arctic Coast (Rausch, 1950a), and dead lemmings were abundant.

Ursus richardsoni is not an exceptionally large bear, although it is a very powerful animal. A large male, killed on 15 October 1950 when it was fat, weighed 580 pounds. According to the Nunamiut, this bear was as large as any they had seen; it measured 1,850 mm. in total length, and the length of the hind foot was 303 mm. A very old bear (*ahgayukaksrapiagatak*), killed on 9 November 1950, measured about 1,900 mm. in length, with a hind foot length of 280 mm., and weighed only 365 pounds. This bear, the oldest obtained, was in poor condition, possibly as a result of old age, and its teeth were very badly worn and broken.

The arctic grizzly shows considerable variation in colour. This may be partly relative to time of year, but is mainly due to individual variation. Two

female cubs, one of which was dark and the other light, were killed with their mother on 11 July 1951 by the Eskimo on Anaktiktoak Creek.[1] In some animals, head, neck, and shoulders are very pale, sometimes almost buffy-white, and the legs and belly are dark brown. In the fall the hair is shorter and much darker, although the dorsal hairs have lighter tips and later become lighter throughout. Some animals, such as the old bear mentioned above, are very pale, even in the fall.

The claws of the arctic grizzly are long and moderately arched; they range from dark brown through horn-colour to white. The longest claw of the fore foot measures from 53 to 77 mm., with an average of 60 to 70 mm.

A good series of skulls, several with skins, has been obtained, and is now in the collections of the U.S. National Museum and the National Museum of Canada. Rather striking variation is seen in some of the skulls, but I attribute this to normal age and sex differences, and to individual variation. From a study of other skulls available from this locality, it would seem that skull growth and changes in skull conformation continue throughout the life of the animal. The most aged animals examined showed the greatest extremes in skull measurements. The skulls of these bears have been compared with those of *U. toklat*, from which they differ in minor detail. Minor differences were also observed when these skulls were compared with those of unidentified bears from Jarvis Creek, in the Biological Survey Collection. The significance of such differences cannot be determined from the limited material now available. Table I gives skull measurements for *U. richardsoni*.

Sex	*Condylobasal length*	*Zygomatic width*	*Palatal length*	*Interorbital width*	*Last molar length*	*Locality*
♂ (2-to 3-yr.-old)	266	155	—	60.2	37.8	Canning River
♂	276	172	154.5	74.4	36.4	Tulugak Lake
♂	318	189	163	69	40	Tulugak Lake
♂	318	194	161.6	73.6	38.5	Tulugak Lake
♂	324.5	219	177	78	36	Ikiakpuk Creek
♂ (aged)	331	223	168	79	35	Tulugak Lake
♂	337	219	177.4	82.5	36.7	Tulugak Lake
♂	—	—	148	72	32	Alaktak River
♂ (old)	339.5	220	177	78	35	Savioyok Creek
? ♂	343	206	163	58	36.5	Tulugak Lake
♂ (aged)	358.5	233	181.5	85.5	36	Savioyok Creek
♀	286	174	139	66	33	Tulugak Lake

Table I. Skull measurements of 12 specimens of *Ursus richardsoni* (in millimetres).

The skull of a cub, killed on 23 September 1948, allows the following observations on the rate of irruption of the permanent dentition:

The permanent first upper incisors are in place, and the second incisors are just emerging. The deciduous third incisors are still present, although the points of the permanent teeth are visible. The deciduous canines are still in place, but the permanent canines can be seen coming through anterior to them. On the right side, two premolars are present, and on the left there are three. The first upper molar is in

[1]The skins of these cubs have been deposited in the U.S. National Museum.

place, but the second has not yet appeared above the level of the palatine bone. The alveoli of these extend backward into the zygomatic space to slightly beyond the posterior limits of the median part of the palatine bone. In the mandible, the first two permanent incisors are present, and the third is coming through on each side. The left deciduous third incisor is still in place, but the right one has been lost. The canines are in a state of development similar to those of the maxillae. There are three premolars on the left, and two on the right. The permanent first molar is in position, but the second is still partly imbedded at its posterior end, although the entire tooth is visible. The third molar is completely concealed. The condylobasal length of this skull is 199 mm., and the zygomatic width is 119 mm. The degree of elimination of the posterior extension of the alveolus of the last molar is closely associated with the age of the animal.

The Nunamiut are very successful in hunting the grizzly bear, although no great effort is made to obtain them. Eight bears were killed in the Tulugak Lake region in 1948; 5 in 1949; 11 in 1950; and in 1951, up to the middle of September, only 4. Three animals of the same size, apparently two-year-olds, were killed together in 1950 as they travelled to the north over a snowfield west of Tulugak Lake. Four adult-size bears were observed together by the Eskimo during early September 1951.

These grizzlies are ordinarily killed with small-calibre rifles, in contrast to the usual practice of the white man. The Nunamiut rarely kill bears with any gun larger than the .30-30, and both .25-35 and .25-20 are commonly used. Paneak claims to have killed 9 of these bears with a .22 Hornet; only one came towards him, and he killed it with a second shot in the head; one besides these, escaped. It is the practice of the people to approach a bear as closely as possible before shooting. They often shout first, so that the bear, if only wounded, is not likely to run in their direction.

Even before modern rifles were available, I have been able to learn of only two Nunamiut fatalities caused by bears. Maptigak, now an old man, told of a case where four hunters went after a bear during the winter along the Colville. One man shot it with a flintlock gun, but the bear had much ice in its fur, and the bullet did not take effect. The man was attacked and killed. The grandfather of Inyualuruk, one of the older men of the group, was killed by an ice-covered bear as he attempted to spear it. This was before Inyualuruk's father was old enough to hunt for the family, so the death brought much hardship. It is of interest that the Indians farther east have a superstitious fear of such ice-covered bears and refuse to hunt them.

In earlier times the Nunamiut observed certain customs and superstitions when hunting bears. For instance, it was unwise to boast about killing bears, since the animals would hear and would not easily then be killed. Stefansson (1914) reported this superstition to be held also by the Eskimo east of the Mackenzie. After the killing of a bear, a gun was called "*achlachtun*", and had to rest for four days after the killing of a male bear and five after a female, before it could be used for caribou, or it would bring bad luck.

Bears were usually killed with spears in pre-firearm times. According to the Eskimo, the bear spear had a head made from flint or from the forearm bone of a bear, and a shaft about eight feet long. The butt of the spear was placed firmly against the ground, before the bear attacked, and when the animal

lunged at the hunter, it became impaled. Some bears were killed by bow and arrow. One man would infuriate the bear until it charged him, and he would then lead it past the hunters in ambush.

Grizzlies were killed in the winter whenever one could be found in a den. Before an effort was made to kill the bear, the hunters used to defecate upon the earth dug from the den. They believed that doing so would ensure their finding a bear inside. For killing the bear, a triangular frame was prepared by binding together three heavy willow sticks, with a fourth placed from the base to the apex to give additional strength. The apex of this frame was inserted into the den mouth, and a certain phrase ("*Nami kamma*", meaning approximately "Is anything in?") was called out. The aroused bear would seize the wood and try to pull it into the den, and while thus occupied it was speared. These customs are no longer followed.

In timbered country bears were sometimes snared. A noose was placed above the trail, with the line running upward over a branch of a tree or through a hole in the tree itself. This line was attached to a very heavy log carefully balanced on end against the far side of the tree. When the bear pulled against the noose, the log was dislodged and its weight tightened the loop.

It is of interest that the Nunamiut have no knowledge of the breeding habits of the grizzly bear, and there is considerable speculation as to breeding time. An Eskimo named Tumaitchak, who was supposed to have killed more than 40 bears, observed a bear around the mouth of a den in December. The hunters went after this animal and killed it; it was found that it had just given birth to a cub. Twin cubs are the rule.

A. Murie (1944) has reported various observations on the relationship of wolves and grizzly bears. In the Brooks Range there appears to be frequent friction, resulting at times in actual combat. One of the Nunamiut, Kakinya, in the spring of 1939, came upon a bear and shot it. When he fired, three wolves, which he had not seen, ran out from nearby and escaped. Upon skinning the bear, he found it to have been severely bitten around the back and rump. It is not unusual for bears to drive wolves from their kills, but the bears seem to show fear of wolves. In early October 1950 I observed from the tracks that an adult bear sleeping in a creek bed high on a mountain side had been disturbed by a very large wolf. The bear left at a run and did not slow its pace until well down the mountain. Maptigak said that wolves often chase bears, and that bears always show fear of wolves. Arthur O'Connell, who has trapped for many years along the North Fork, stated that he has seen evidence of bear–wolf fights, and has found wolves killed by bears.

As far as can be judged from available information and personal observations, the numerical status of the arctic grizzly is good. Very old bears are not uncommon, indicating that these animals live, in general, unmolested. The Nunamiut do not recognize any decline in numbers, and in view of the relatively small region over which they hunt, they can have little effect upon the over-all bear population. It is unlikely that this animal will suffer a serious reduction in numbers unless they are subjected to considerable hunting by the white man.

Ursus americanus Pallas ssp. *Igakrik*. Black bear.

The black bear rarely comes as far north as this region. I have not seen it farther north than Crevice Creek, which is several miles south of Hunt Fork. Frank Bishop, who has trapped along the John River for more than thirteen years, told me that the black bear occurs on Hunt Fork; he believed that it avoids the timbered country farther north where the grizzly bear is numerous. However, black bears are common along the south front of the Brooks Range, around the mouth of the John River valley and, on one day in September 1950, I saw 4 black bears between the mouth of the John River and Crevice Creek while flying north up the John River valley.

Only one specimen of black bear, a young male, has been secured from the Anaktuvuk Pass region. On 18 June 1951 it was killed by the Eskimo near the mouth of Inukpasukruk Creek. The length of this animal was 1,360 mm., and, as far as could be determined from its skull, when compared with skulls of captive bears of known age, it was about two years old.

The black bears are usually in their dens when the Nunamiut are in the timbered country, so there is little contact. The Eskimo are well acquainted with this species, and observe it from time to time, but know little about it. Maptigak reported having seen a wolf chase a full-grown black bear up a tree.

Vulpes fulva alascensis Merriam. *Kayuktuk*, fox; *Kaviak*, red fox; *Kiangak*, cross fox; *Kiknyiktak*, silver fox. Alaska red fox.

In the Brooks Range and over the Arctic Slope the red fox is one of the most common animals. Cross and silver colour phases are regularly seen. No information of particular interest has been obtained. I know of two cases where golden eagles have attacked red foxes without success. This has been reported also by Dixon (1933) and A. Murie (1944). In the main valley fox dens are found in knolls along the rivers. The Nunamiut name for fox den is *sisrak*.

The Nunamiut formerly used several methods for taking foxes. A snare, called *kilusaktuk*, was used to encircle the den mouth, but no one now living knows the details of its construction. A deadfall, called *nanmautalik*, was commonly used; it consisted of a platform of willow sticks loaded with stones. This was suspended from a bough of a willow tree by a single line so arranged that the platform fell when the line was cut. The line was fastened at the ground, and some fat was allowed to freeze on it. In attempting to chew off the frozen fat, the fox severed the line and was killed by the falling weight.

A more elaborate trap, used by the fathers of the men now living, was a sinew net called *porgoh*. This net, tied from caribou sinew, was about six feet wide, and was placed upright in a semicircle. Near the opening a small snow-house was built, just large enough to contain a man. A caribou carcass was placed inside the net, and the hunter would spend the entire night in the snow-house, watching through a small observation hole. When foxes or wolves came in to the bait the hunter would burst from the blind, and in their frantic efforts to run in the opposite direction, the animals became entangled and could be killed. The mesh of this net was large enough to catch the head

of a wolf, but not so large as to allow foxes to escape. This trap was mentioned by Stefansson (1914, p. 388).

The *isivrogak*, consisting of a strip of baleen sharpened at both ends, coiled, and frozen inside a ball of blood, was formerly used by the Nunamiut for both foxes and wolves. The proper length of the *isivrogak* for foxes was equal to the distance from the middle of the palm of the hand to the end of the longest finger. Such baits were placed where they would be swallowed by foxes or wolves, and when the body heat had thawed the ball, the *isivrogak* sprang straight, penetrating the wall of the stomach and sooner or later causing death. This is a well-known Eskimo method, and has been discussed more fully by other writers.

The Nunamiut do not use fox fur themselves, but foxes are trapped for trade.

Eight fox skulls have been deposited in the U.S. National Museum. A large series is in cold storage. A total of 32 specimens from the Anaktuvuk Pass has been autopsied for parasites.

Alopex lagopus innuitus (Merriam). *Tereganiak*. Continental arctic fox.

The arctic fox is of irregular occurrence in the Brooks Range, but I have not yet secured a single specimen, though several reports of this animal have been obtained. Six were killed just north of the mountains near Chandler Lake in 1936; 3 were killed on the Killik River in 1941; and one was killed on Easter (Agiagiak) Creek and another on April Creek, both tributaries of the Killik, in 1947. According to one report, arctic foxes may even cross the Brooks Range. David Tobuk, an Eskimo living in the village of Bettles, told me that an arctic fox was killed by an Indian on Henshaw Creek, about ten miles south of Bettles, around 1910.

Perhaps such wanderings of the arctic fox occur during the times of high fox population following a periodic decline of lemmings on the Arctic Slope. The few records given here correspond closely to years following times of known high lemming density.

Canis lupus tundrarum Miller. *Amaguk*. Alaska tundra wolf.

Wolves occur commonly in the Brooks Range, but no observations of unusual interest have been made. The excellent report of A. Murie (1944), on the wolves of the Mt. McKinley region, contains the most complete information available on Alaskan wolves. The relationships of wolves to the other animals of the Brooks Range are no doubt very similar to those in the Mt. McKinley area.

Wolves have not often been observed in large packs in the Brooks Range, and are usually seen in groups of 3 to 6. A pack of 15 animals was seen by the Eskimo during the winter of 1950. Paneak stated that a pack of 18 animals seen a few years back was the largest ever observed by him. In general, wolves are to be found wherever there are caribou.

There is much variation in wolf colour in this region. Grey or black are the common colour phases, and light-coloured animals are not often seen. Some few animals are relatively pale, but even in these the dorsal hairs are

Fig. 13. Trapped wolf, Savioyok valley, April 1950.

heavily tipped with black. Rufous-coloured animals are occasionally seen, and I examined one skin which was heavily tinged with ochraceous-orange.

Wolves commonly den along stream banks, but dens are also found rather high in the mountains. One litter was removed from a limestone cave in the mountain just north of the mouth of Anaktiktoak Creek. Litters usually run from 3 to 6 cubs.

The tundra wolf is not exceptionally large. A few animals, killed conveniently near camp, were weighed (Table II). No effort was made to look for unusually large animals.

Rabies outbreaks in wolves have been known to occur in the Brooks Range,[1] as well as in other parts of Alaska (McTaggart Cowan, 1949). The last of these was during the winter of 1944–5, when rabid wolves occasionally

[1]This diagnosis is based on verbal descriptions only; however, properly diagnosed cases are known from other parts of Alaska, and I have personally obtained animals in which rabies was diagnosed on the basis of the mouse inoculation test.

came into the Eskimo camps, where they were killed. An aged man, the father of Kakinya, was attacked by a rabid wolf and bitten on the hand. He succeeded in killing the animal, and suffered no ill effects from the bite. Dogs attacked by wolves in camp at night became rabid. A rabid wolf was seen pursuing another apparently normal wolf which, in its desire to escape, ran close to a hunter and was killed. The rabid wolf, showing no fear of man, came near and was also shot. This outbreak followed a year of high wolf density, according to the trapping success of the Nunamiut. The resulting decrease in numbers, however, was apparently not great. There are no reports of attacks on man by normal wolves.

Sex	*Weight*	*Sex*	*Weight*
♂	55	♀	73
♂	75	♀	80
♂	78	♀	81
♂	80	♀	85
♂	106	♀	85
♀	59	♀	87
♀	63	♀	90

Table II. Weights of 14 wolves from the northern Brooks Range (in pounds).

The Nunamiut stated that wolves were rare in the Anaktuvuk Pass region from about 1911 to 1920. During this time caribou were also scarce, perhaps as a result of their following migration routes which did not take them through this country. For the last few years wolves have been numerous; usually from 20 to 30 are trapped each winter, but more than 150 were killed in the winter of 1942–3. Forty-eight wolves were killed during the winter of 1949–50. They are occasionally shot during the summer and fall, but no effort is made to trap them in these seasons.

I have never seen a place with as many wolves as the Savioyok valley during the early winter of 1950–1. The Eskimo who went into this valley shortly before I did reported that they were unable to sleep the first night because of the noise made by the wolves howling, and their own dogs replying. It is interesting that the greatest density of mountain sheep and moose that I have seen in the Brooks Range was found in this valley, despite the relatively large wolf population.

A series of 15 wolf skulls has been deposited in the U.S. National Museum. A larger series of skulls, as yet unprepared, is in cold storage.

Martes americana ?actuosa (Osgood). *Kaviatchiak* ("new wolverine"). Alaska marten.

The marten is rare in the Anaktuvuk Pass region, and only one specimen, from Hunt Fork, was obtained. This animal was trapped by an Eskimo during the winter of 1948. According to Frank Bishop, marten do not occur far up the John River valley. It is possible that they are more abundant on the North Fork drainage where only a limited amount of field work was done. Marten tracks were observed in the Savioyok valley in the winter of 1949–50.

The single marten obtained differs considerably from any specimen in the mammal collections at the U.S. National Museum. The ochraceous colouring

is limited to the posterior third of the dorsal part of the body. The head is very pale grey, with a slightly darker median streak which gradually darkens and extends the full length of the body. No throat patch is present, and the entire throat is grayish buff. The fore feet and legs are nearly black, and the hind feet and legs are very dark with a light area on the front of the leg just above the foot. The tail is mostly dark, with some orange-tinted hairs interspersed. The dorso-posterior third of the body is bright orange, similar to Ridgway's Ochraceous Orange. This animal, a male, weighed 1,050 grams. The cranial differences do not seem significant on the basis of a single specimen.

According to the Nunamiut, ptarmigan and mice form the main diet of the marten in this region, but no personal observations were made.

Mustela erminea arctica (Merriam). *Iteriak* (from *iteriaktuk*, "to get up early"). Ermine.

Ermine are common in the region, presumably because of the favourable habitat and abundance of voles. Twelve skins and skulls were deposited in the U.S. National Museum in 1949–50, a series of similar size is now in cold storage, and others have been autopsied for parasites. The Nunamiut usually trap 40 or 50 of these weasels each year.

The ermine apparently does not range very high on the mountain sides, but its tracks are found up most tributaries of the Anaktuvuk and John rivers. Tracks are frequently seen around wolf-kills and around deadfalls set for wolverine. Dens are found among rocks in favourable places, or in knolls along the rivers. The ermine does not seem to have many enemies in this region. The golden eagle and gyrfalcon may kill a few, but the snowy owl, its main predator on the Arctic Slope, is uncommon here.

The molt into winter pelage takes place in late September and in October. There is no uniformity in this, and individuals ranging in colour from that of summer pelage to nearly pure white may be caught within a few days' time.

Mustela rixosa rixosa (Bangs). *Naulayuk*. Least weasel.

Although widely distributed and well known to the Nunamiut, the least weasel is rarely seen, but tracks are occasionally found around vole burrows and along the creeks in winter.

Four specimens so far obtained were taken more or less by accident in mouse traps. Three of these were in winter pelage, and one, caught in late May, was in summer pelage. A male animal collected 20 March 1951 did not show any beginning of molt into summer pelage. The weights and measurements of the animals are as follows:

Sex	*Weight*	*Total length*	*Tail*	*Hind foot*
♂	51.0 grams	177 mm.	19 mm.	24.5 mm.
♂	31.4	170	19	24
♀	28.0	149	10	17
♀	26.0	155	17	22

Mustela vison Schreber ssp. *Iteriakpuk* ("big weasel"). Mink.

The mink is rare and is perhaps never resident in the Anaktuvuk and upper John River valleys. Tracks at Chandler Lake and along Hunt Fork were

reported by the Nunamiut. I saw tracks in the upper Savioyok valley in the fall of 1950, and it is possible that mink are permanent residents in this valley as the creeks are kept open all winter by flowing springs. The invertebrate fauna of these creeks is abundant, and a small arctic char, *Salvelinus alpinus* (L.), is common. No specimen of mink has been obtained.

Gulo luscus luscus (Linnaeus). *Kavik*. Wolverine.

The wolverine is widely distributed in this region. Eight skulls have been obtained; their measurements are given in Table III.

Sex	*Condylobasal length*	*Zygomatic width*	*Squamosal constriction*	*Coronoid height*	*Maxillary tooth row length*	*Interorbital width*
♂	140.7	101.2	77	50.5	51.3	38.6
♂	141.6	101	78	48.7	51.9	38.6
♂	143.7	105.1	80.6	50.5	52	43.4
♂	144.5	103.4	80.7	51.2	51.5	42.6
♂	145.5	104	76	52	54	39
♂	146	106	77.5	52.5	54	41
?	147.5	107.5	76.1	50	54.9	42.5
♂	155.5	111	86	53.5	57	41

Table III. Skull measurements from 8 wolverine collected in the Anaktuvuk Pass region (in millimetres).

Degerbøl and Freuchen (1935) were of the opinion that the North American and European wolverines belong to the same species. This conclusion does not appear to have had the support of American mammalogists. However, in view of the ever-increasing number of species now recognized to have a circumpolar distribution, it would seem that the wolverine will likewise have to be considered a circumpolar species. I have not compared the skulls of Brooks Range wolverines with those from Eurasian animals.

A large male wolverine, trapped 20 October 1950 at the mouth of Anaktiktoak Creek, measured 925 mm. in total length and weighed 34 pounds. The Nunamiut remarked that they had never seen any larger than this.

The Eskimo maintain that the male animals are most often dark-coloured, while the females show prominent lateral streaks. On the basis of a relatively small number of skins examined, this appears to be the case. There is much colour variation; the lateral streaks vary from nearly white to rufous or brown, and in some males are hardly visible.

The food of the wolverine consists mainly of snowshoe hares, a good proportion of mice, and occasional wolf-kills and other carcasses. Under favourable conditions a few sheep are killed, or, rarely, a caribou.

From 3 to 6 wolverine are trapped each year by the Nunamiut, who use the fur for parka trimming. In some years as many as 12 to 15 are killed. I have not heard of any case of wolverine robbing caches in this country; this is probably because of their general scarcity. The Nunamiut ordinarily trap wolverine in rock deadfalls. These are set in the fall, using as bait the nose or foot of caribou, which cannot readily be destroyed by voles. The site is selected with considerable care, so that the deadfall will not be covered by snow. Many such traps can be set, and it is not necessary to check them until

spring since any animals caught remain frozen and in good condition. A spruce deadfall, called *nanugotalik*, is used in the timbered country. This is made of spruce trunks loaded with rocks and a spruce trigger with a length equal to that of a man's arm from the axilla to the base of the hand.

None of the Nunamiut has seen a wolverine den, nor do they know anything of the animal's breeding habits. Inyualuruk reported that in the spring a wolverine, with two small young, was killed in a den in the snow near the north edge of the mountains.

Lutra canadensis (Schreber) ssp. *Pamioktuk* ("big tail"). Otter.

It is doubtful if any otter are resident in this region. Tracks are seen at times along Hunt Fork, and one animal was seen at Kanayut Lake in 1950. No specimen has been obtained. The Nunamiut know the otter, although few of them have seen it. It is possible that otter visit the Savioyok valley from time to time, but here also they must be of only casual occurrence.

Lynx canadensis canadensis Kerr. *Niutuyik* ("long legs"). Canada lynx.

The lynx occurs in the timbered sections of the region, and in some years may be found far to the north of the last spruce timber. Such variable occurrence is, of course, closely connected with the abundance of snowshoe hares. I have obtained a specimen from as far north as the mouth of Publatuk Creek, near the last spruce timber, and another from Hunt Fork, where tracks were common during 1949–50. Both specimens have been deposited in the U.S. National Museum. Lynx tracks were abundant in the Savioyok valley during the winters of 1949–50 and 1950–1, but no specimen was obtained. The Eskimo recall having seen lynx as far north as Tulugak Lake in the winter of 1916 or 1917.

The Nunamiut snare an average of about 5 or 6 lynx a year, but no particular effort is made unless fur prices are high.

Lepus americanus dalli (Merriam). *Ugalik*. Snowshoe hare.

The snowshoe hare ranges as far north as Kalutak Creek, where it is found in the willows along the main valley. It is, however, much more common in the timbered country to the south and east. Although only 4 skins and skulls have been deposited in the U.S. National Museum, a large series has been autopsied for endoparasites.

According to the Eskimo, the hare population does not show marked fluctuations in this region. This has been substantiated by Frank Bishop, who stated that the last hare "high" in the country around the mouth of John River took place during 1946. The lynx decreased soon after this time, and I obtained a nearly starved lynx near the village of Bettles as late as the fall of 1949. Bishop also observed a heavy mortality in willow ptarmigan during 1945.

Snowshoe hares are easily taken during the winter months, but I have not yet obtained a specimen in summer pelage, so subspecific determination should remain tentative for this form. A young animal not completely molted into winter pelage was taken in a wolf trap in the Savioyok valley during late

October 1950. It was so badly damaged, however, that it was not retained.

The Nunamiut capture hares by sinew snares during the winter, but since relatively few are obtained they are of little importance in the diet of the people.

Lepus othus othus Merriam. *Ugalishugruk*. Arctic hare.

It is possible that the arctic hare may occasionally be found near the northern limit of the Brooks Range, although little information is available. The Nunamiut reported having seen this hare near Umiat on the Colville River and near the mouth of the Anaktuvuk. The Killik people formerly travelled in this region, but have not done so in recent years. In a letter quoted by Howell (1936 a, p. 334), Charles D. Brower writes: "Several times I have had these large hare skins brought into Barrow by natives wintering up the Colville River". I have made a number of flights by small aircraft over this country just before snowfall, but sufficiently late in the year for the hares to be white and easily visible, but I have yet to see one.

Marmota caligata broweri Hall and Gilmore. *Sikrikpuk*. Hoary marmot.

Until the present material was obtained, this hoary marmot was known only from Point Lay and Cape Thompson (Hall and Gilmore, 1934). Scattered colonies occur commonly in the Brooks Range, and it is often locally abundant. There is one colony about ten miles south of Tulugak Lake, and others are found near Anaktuvuk Pass. The Nunamiut say that it is common near the head of the Killik, also that marmots are found among some sandstone cliffs from thirty to thirty-five miles north of Tulugak Lake.

Marmots from northern Alaska have been mentioned in the papers of Bailey and Hendee (1926) and Hall (1929). Anderson (1934) published a map of North American hoary marmot distribution, but at that time had no information on the Brooks Range form. I have so far obtained 8 skins and skulls of this species from Anaktuvuk Pass, in addition to 7 skins only. The skin and skull of an adult marmot of this species were obtained near Arctic Village, on the Chandalar River, and I have examined skins typical of this form from Big Squaw Lake, farther south near the village of Chandalar. Although considerable effort was made to obtain marmot specimens in the Romanzof Mountains, near Lake Schrader and Lake Peters, I was unsuccessful. It is nevertheless clear that *M. caligata broweri* is the form found throughout the Brooks Range, probably as far as the Alaska–Canada boundary.

Brooks Range marmots enter the dens for the winter not later than the middle of September. The exact time of emergence in the spring is not known, but as late as 21 May 1950 marmot dens were still snowed in, so it would seem that emergence must take place in June. By this month much vegetation is already available for food, particularly saxifrage. *Saxifraga bronchialis Funstonii* (Small) Hult. and *Pyrola grandiflora* Radius are important as food. *Therofon Richardsonii* is eaten, as are lupine and various other legumes.

Dens may often be seen from a great distance as the surrounding vegetation is more brown and the nearby rocks may be orange from the brightly-

coloured lichen, *Caloplaca granulosa* (Müll. Arg.) Steiner. This lichen is a strongly nitrophilous species, which flourishes where there is marmot urine, It is also frequently seen around bird rocks. Marmot dens may be found in both limestone and conglomerate rock, and there is usually a nearby source of water.

The most important predator on the marmot in the Brooks Range is the golden eagle, which occurs in good numbers. The fox may be second in importance.

The Nunamiut trap marmots by rock deadfalls. The skins are sold for making parkas, and the carcasses are eaten. Marmots are a particularly useful source of food as they are available in the summer when caribou are often few or entirely absent.

Citellus parryii barrowensis (Merriam). *Sikrik*. Parry ground squirrel.

The ground squirrel is one of the most abundant and conspicuous of the Brooks Range mammals. It is found in a variety of habitats, from sandy river banks to high mountain sides, wherever the vegetation is low or sparse, and occurs in most of the previously mentioned plant communities which grow on drier ground. It is common on the mountains to at least 3,500 feet, in rocky areas grown to *Cassiope* and lichens.

Hibernation usually begins in late September or early October, and tracks are not uncommonly seen in the first snows of fall. In 1949 I saw squirrels on September 22, 28, and 29, and in 1950 on September 28 and October 3. They were scarce in September 1951, probably remaining in their burrows during the unusually poor weather of this month. Activity outside the burrow is intermittent and depends upon very favourable weather and sunlight.

The squirrels emerge from hibernation very early, about March 25 to April 15, when the only evidence of the coming spring is the increasingly longer period of daylight. By the latter part of April their presence is evident from tracks in the snow on bright, sunny days. On dark and windy days they remain inside the burrows, which are repeatedly filled with snow by the storms of early spring. Their early spring activity is interesting; they often emerge from a burrow and take a direct course across the snow for as much as fifty yards, where they dig down to the mouth of another burrow. The reason for this behaviour is not apparent, but they seem to leave one burrow for another, since returning tracks are rarely seen. Possibly at this time the males are seeking females.

In the early spring the squirrels feed largely on willow, as indicated by stomach contents. Later their diet is made up from a variety of plant species.

Breeding appears to take place in late April or early May, and the male animals are first to emerge from hibernation, according to the specimens examined. By the last part of May the females have well-developed embryos in the uterus. By early July the young animals are well grown, and by mid-July weigh around 360 to 380 grams.

Thirty-eight squirrels were collected in 1949; 16 in 1950, and only 9 in 1951. Most of these were autopsied only. Eight skins and skulls were

deposited in the U.S. National Museum in 1949 and additional specimens have since been prepared.

The total length as given by Hall (1929) is large for the Brooks Range specimens. Male animals, collected in early May, measured from 370 to 380 mm., and females from 340 to 352 mm. For males, the tail length ranged from 97 to 101 mm., and the foot length from 54 to 63 mm. Nine male animals, collected from 4 May to 6 May 1949, weighed from 530 to 977 grams (av. 653 grams). Weight, of course, depends upon season, and the heaviest animals are obtained just before hibernation.

When caribou are scarce the Nunamiut sometimes kill ground squirrels for food. They are taken by snares, and, in recent years, by steel traps. Earlier custom required that a period of time had to elapse after squirrel had been cooked before the pot could be used for any other meat.

Tamiasciurus hudsonicus preblei Howell. *Sakalatayik.* Mackenzie red squirrel.

The red squirrel does not extend beyond the northern limit of spruce timber. Seventy-six specimens were obtained in 1950 from the last timber on the John River and from the Savioyok valley. Four specimens were deposited in the U.S. National Museum in 1949; a larger series is waiting to be deposited, and more than 20 are in cold storage. No specimen has been obtained in summer pelage as practically all summer field work has been north of timber. The Brooks Range red squirrel reaches a total length of as much as 376 mm. Six adult females, taken in March, averaged 229 grams in weight, and 6 adult males, taken at the same time, averaged 258 grams. This is obviously a larger animal than the specimens upon which the subspecies *preblei* is based (Howell, 1936b). It is possible that further study will show that this squirrel represents a distinct form.

In the Savioyok valley, red squirrels ranging in colour from an unusual pure ochraceous colour to the normal colour have been taken. The palest animal had only a few dark hairs along the lateral streaks and on the front legs, the face, and margins of the tail.

In general habits, this animal does not differ from the same species farther south. To my knowledge the Nunamiut do not make any use of the red squirrel.

Lemmus trimucronatus alascensis Merriam. *Avingak.* Alaska brown lemming.

The status of the brown lemming in the Brooks Range is difficult to determine. I have secured a few specimens south of Tulugak Lake, but it has been uncommon during the time of this work.

On 6 May 1949, when the spring thaw was just becoming evident, I saw a brown lemming on a small snow-free area near Tulugak Lake. On July 12 the first specimen, an immature animal weighing 20 grams, was trapped in "niggerhead" tundra in the main valley, just east of Tulugak Lake. From September 12 to September 26, however, 14 were obtained in the area of the flowing springs near the lake. These September specimens weighed from 18 to

35 grams (average about 25 grams); no adults were taken. In the Savioyok valley 3 adult animals were taken on 15, 16, and 17 December 1950. None otherwise has been obtained from the timbered sections of the region.

No special effort was made to trap lemmings and all specimens were taken during general trapping for small mammals. As mentioned elsewhere (Rausch, 1950a), brown lemmings were most readily taken in unbaited runway sets.

The Nunamiut, who are familiar with the population fluctuations of the brown lemming along the Arctic Coast (see Rausch, 1950a) stated that they had never known a high population density in the Brooks Range. During the summer of 1951, this species was abundant in the Romanzof Mountains near Lake Schrader and Lake Peters, and a good series was collected.

Dicrostonyx groenlandicus rubricatus (Richardson). *Kilakmiutak* ("sky animal"). Alaska varying lemming.

The varying lemming is well known to the Inland People, who share the common Eskimo legend that the white lemming falls with the snow from the sky. I have seldom seen this animal south of the divide between the rivers, but the Eskimo stated that they had seen tracks as far south as Hunt Fork. This lemming often occurs high in the mountains, and I have seen its characteristic tracks in the pass leading down into the Savioyok valley. These animals travel for great distances on the snow surface; this behaviour has been noted by Degerbøl and Freuchen (1935, p. 88) and other writers.

A total of 5 specimens was obtained in 1949; 7 in 1950, and 4 in 1951. Tracks were seen occasionally, but the animal could not be considered common. No specimens were taken in traps; all were captured by hand on the tundra.

The molt into summer pelage takes place during late April and early May, but the time it is complete is not known. In the fall, the molt occurs mainly during September. A specimen collected on 24 September 1949 showed some white hairs in the coat, but the head was still dark and the dorsal stripe was distinct; the snow claws were beginning to grow. A specimen obtained on 25 September 1950 was white except for the ears; another collected on 9 October 1950 was quite pale, but still showed traces of the summer pelage; and one taken on 18 October 1950 showed a slight grey tinge. It is evident that the molt takes place much earlier in the spring and much later in the fall than it does on the Arctic Coast.

Very little was observed on the breeding of this animal. A captive female gave birth to 6 young on 27 April 1949. A nest containing 4 young was discovered in a short burrow on 17 July 1951 at Lake Schrader.

A few observations were made on the feeding habits of the varying lemming. One animal had a leaf of *Ledum* in its mouth when it was captured, and another had a leaf of *Dryas integrifolia*. An animal captured on 25 September 1950 was carrying moss, *Rhytidium rugosum*, into its burrow, presumably for a nest.

According to the Nunamiut the varying lemming never becomes abundant in this region. This species was rather numerous in the Romanzof Mountains during the summer of 1951 and a series was collected there.

Clethrionomys rutilus dawsoni (Merriam). *Avingak*. Red-backed vole.

The red-backed vole was the second most common mouse-like rodent in this region. It was trapped most often in the lower country, particularly in the main valley, but it was also taken at altitudes up to 3,000 feet. This vole was found in a variety of habitats, but apparently preferred *Salix* and *Salix–Betula nana* communities where the ground was covered with dense moss. I collected a few specimens at Umiat on a dry slope heavily grown to *Salix* spp. and *Alnus crispa*, above a dense growth of mosses and lichens.

The burrows of the red-backed vole were common in moss hummocks around the base of willows, particularly in the spring-area at Tulugak Lake. Small round burrows were found among limestone talus overgrown with *Cassiope*, near the top of a low mountain at an altitude of more than 3,500 feet. Characteristic fecal deposits were noted at the entrance to the burrows.

In the winter, tracks showed that this vole fed on wolf-kills and other available carcasses, but no other observations were made on their feeding habits.

Red-backed voles were readily trapped in the winter, in contrast to the other species of microtine rodents in this region which, with the exception of *Dicrostonyx*, remain under the snow.

As is characteristic of voles of the genus *Clethrionomys*, the Brooks Range specimens show much variation in colour, ranging from a buffy-brown to a striking ochraceous-orange. Part of this variation is, of course, seasonal, but in general colour has little taxonomic value in this group (see Rausch, 1950b). The maximum weight of this animal rarely exceeds 30 grams.

More than 100 specimens have been collected from the Anaktuvuk Pass region, but relatively little information was obtained on breeding habits. Breeding apparently begins in May and has stopped by early September. More than 70 animals have been collected in the Savioyok valley, and a few at Umiat. One specimen was taken during July 1951 at the south end of Lake Schrader in the Romanzof Mountains, and a series was obtained at Arctic Village.

Microtus oeconomus macfarlani Merriam. *Avingak*. Tundra vole.

The tundra vole has been relatively uncommon during the time of these observations, and only 65 animals have been obtained. The majority was taken near the spring-area of Tulugak Lake, but a fair series in winter pelage was trapped during the fall of 1950, just south of the divide. Two specimens were taken in the timbered Savioyok valley; one was taken on the tundra just north of the mountains, and a few were found frozen in an Eskimo cache on the Killik River. The tundra vole is distributed over much of arctic Alaska[1]. A few specimens were obtained at Umiat and at Bettles, near the mouth of John River; 5 were taken at Lake Schrader during July 1951, and a good series was collected at Arctic Village. Hall (1929) reported this species from a river, possibly the Meade, about fifty miles south of Barrow.

During these observations the tundra vole appears to have occurred in restricted colonies only. It prefers areas grown to sedge (*Carex* spp.), or various grasses. One specimen was taken in a *Carex aquatilis–C. Bigelowii*

[1]We have also collected large series from regions south of the Brooks Range.

community, and several were taken in a dry area grown to a dense stand of *Calamogrostis inexpansa* A. Gray near Tulugak Lake, where there were many typical *Microtus* runways, with characteristic cuttings.

This vole seems to take readily to the water. One entered a small pond west of Tulugak Lake, in the main valley, and was shot as it surfaced and swam toward the middle of the pond, which was grown around the edges to *Arctophila fulva* (Trin.) and various sedges. The Umiat specimens were also taken in a sedge community along a small lake. Voles of the genus *Microtus* have been reported to swim readily by various authors (Blair, 1939; Hatt, 1930).

Microtus oeconomus seems much more restricted in its habitat than is *M. miurus*, discussed below. Gilmore (1946, p. 41) considered *M. kamtschaticus* (*M. oeconomus*) a dominant form, and stated that: "This ultimate glacial . . ., and post-glacial spread of *M. kamtschaticus* pushed *M. miurus* into isolated mountains or peripheral localities." *M. miurus* was very abundant in the Brooks Range during the time observations were made, and occurred in a great variety of habitats at all altitudes, while *M. oeconomus* was not common and occurred in restricted habitats on the floor of the main valley. It would seem that *M. miurus* is more restricted by factors connected with altitude and latitude than by competition with *M. oeconomus*.

According to the observations of Quay (1951), a closely-related form, *M. oeconomus operarius* (Nelson), was found to prefer very wet areas on the Seward Peninsula. The Brooks Range animals did not show a marked preference for any one habitat, but appeared to be restricted by altitude. Observations over much of the Territory indicate that both subspecies are found in a variety of habitats. During the time of these observations, breeding was restricted to the summer.

Microtus miurus paneaki Rausch. *Avingak*. Narrow-skulled vole.

This vole was the most abundant microtine rodent of the region throughout the observations, but a definite decline in its numbers was noted by September 1951. More than 300 were obtained, although no effort was made to collect large numbers. The first specimen taken, on an evening in early June 1949, jumped into a small creek and swam for some distance beneath the surface. These voles never hesitated to enter the water in an attempt to escape.

In the Brooks Range narrow-skulled voles were commonly found to an altitude of 3,500 feet and more, and their well-worn runways were often seen on the mountain sides, but preference was shown for wet areas. They were frequently collected on the floor of the main valley. Specimens were trapped in all possible habitats, with the exception of *Cassiope*–lichen communities above an altitude of about 4,000 feet, and *Carex* communities beyond the mountains. Although this species is found around Umiat (Rausch, 1950b), it is not known whether it exists on the open tundra away from the hills, which here reach an altitude of slightly over 900 feet. It would also be of much interest to know whether this vole occurs north of the Colville River. A good series was obtained at Arctic Village and at Lake Schrader, in the Romanzof Mountains, during 1951.

Microtus miurus was seen in isolated colonies in some places where favourable habitat was limited. Seepage areas on the mountain sides, grown to *Therofon Richardsonii* and *Cassiope tetragona* with a dense cover of *Rhytidium rugosum*, though usually quite small in area, often supported a large population. One of the largest colonies occurred in and around a semi-submerged sedge-bog, with the nest burrows in nearby solifluction terraces. Clear-cut runways were not always developed, but were seen best in wet lowlands grown to sedge, on solifluction terraces, and on dry, rocky, *Dryas*-covered slopes.

Runways were seen to extend for considerable distances on the mountain sides. On one south-facing slope, at an altitude of about 2,500 feet, a single, well-worn runway ascended from a creek bed for a distance of fifty-six metres. At its highest point it branched, one branch running east along a solifluction terrace for a further fifty metres, while the other branch ran perpendicular to it for about twenty metres. The main burrows of the voles were in the terrace and in the creek bank. However, thirty-one holes or groups of holes, from one to three metres apart, were found along the main runway up the mountain.

Burrows were numerous, and in the main valley were usually marked by little heaps of evenly-granulated black earth at the openings. Earth expulsion seemed to depend partly on the character of the soil, and was greatest in the late summer when storage chambers were being excavated in small moss-covered hummocks. Excavation of this type has been described by Rand (1945) for *M. andersoni*. *M. miurus* stores the rhizomes of *Carex* spp. and other plants in these chambers for winter use. A typical chamber measured 30 x 20 x 10 cm., and contained 1,367 rhizomes weighing 820 grams. These roots were not identified; however, *Carex aquatilis* and *C. Bigelowii* were abundant nearby. The Nunamiut at times search out such stores for their own use, and caribou may also tear them open with their feet to eat the contents. I found that *M. miurus* at Lake Schrader cached large stores of *Polygonum viviparum* roots; they also dried piles of willow twigs for storage, but I never observed this behaviour in the Anaktuvuk Pass region during three summers' work. Rand (1945) reported that rhizomes of *C. scirpoidea* were stored by *M. andersoni*.

Reproduction began in May and ceased by September 1. The males showed a definite testicular regression by early September. The young number usually from 4 to 8, with an average of 6.

During the spring of 1950 short-eared owls were particularly numerous in areas where this vole was abundant. These were probably migrant birds, since no nests were observed. As mentioned earlier, this vole is often dug out by the arctic grizzly, and is also preyed upon by foxes and weasels.

Four specimens were trapped in the Savioyok valley during October 1950. This vole does not seem to extend far into the timbered country; but the southern limits of its distribution have not yet been determined.

From his observations on a closely-related form, *M. miurus oreas* Osgood, on the Seward Peninsula, Quay (1951) concluded that: "This vole was less generally distributed than *oeconomus* and seemed to have more critical habitat

requirements. It appeared to avoid the wet areas where standing water was present at the surface, and where *oeconomus* was indigenous." As may be seen from the discussion of the habitat of the Brooks Range species, these forms do not seem to agree closely in their habitat requirements. However, such things may be intimately related to population dynamics.

Castor canadensis canadensis Kuhl. *Paaluktuk*. Canada beaver.

Trees cut by beaver in the Savioyok valley are the only evidence of this animal in the region. As far as could be determined from personal observation and information from the Nunamiut, none exists there now. It is possible, however, that they occur some miles farther south in the same valley.

One of the Eskimo, Pilala, reported having found a beaver dam, less than ten years old, in the last timber on the creek leading into Asinak Lake (Loon Lake) in the winter of 1950.

Erethizon dorsatum myops Merriam. *Kingagaluk* (from *kingak*, "nose"). Alaska porcupine.

The porcupine occurs irregularly to the limits of spruce timber, and some years is found much farther north. One was killed by the Eskimo at Chandler Lake in 1943, and another in 1946. Two animals were killed on Kalutagiak Creek in 1948. One specimen was secured from upper Hunt Fork and the skull has been deposited in the U.S. National Museum. Evidence that porcupines have been feeding and the occasional finding of quills show that these animals occur in the Savioyok valley, but so far none has been seen.

Alces americana gigas Miller. *Tutuvuk* ("big caribou"). Alaska moose.

In the main valley as far north as Anaktuvuk Pass, the moose occurs sporadically, and some are seen each year. However, this animal is commonly seen in the lower John River valley and apparently there is a yearly northward movement along the main valley. The Nunamiut stated that moose also move to the north through the valleys of the Chandalar and the Kuparuk. Moose have been known at Umiat for a long time, and in the summer are found as far north as the mouth of the Colville. In the winter, however, they are rarely found beyond the mouth of the Anaktuvuk. Anderson (1924) discussed the northward extension of the moose in Canada. According to the Nunamiut, however, moose have long been known along the Colville, since their fathers and grandfathers hunted them there, and their occurrence in this region does not represent a recent extension of their range.

Although the numbers are perhaps too small to have any significance, it is of interest that most of the moose passing through the main valley to the north are young—usually about three years old. Four animals were seen in 1950, and this is about the usual number.

Moose were abundant in the Savioyok valley in the fall of 1950, where they were observed in herds up to 20 in number, just following the rut. The Eskimo had not hunted there for at least thirty years, and the animals were not accustomed to man. During September, when a few animals were killed for food, bulls were attracted to the spot solely by the sound of the rifle. A bull

was killed which had sustained a completely pierced antler in the fighting which accompanied the rut. An enormous amount of force must have been required to drive a tine through the matured palm of a large bull.

In the main valley the browse supply is sufficient to maintain a large moose population. In the Savioyok valley, where moose are particularly abundant, the effect of their browsing is evident everywhere. However, the vegetation has not yet been seriously damaged. In this valley a trail worn to a depth of more than three feet leads to a moose-lick. According to the Nunamiut, there is also a well-worn lick in the Killick valley, where moose occur in good numbers.

Wolves are abundant in the Savioyok valley, but predation is certainly not detrimental to the welfare of the large moose population. I have seen only one carcass, that of an adult bull. Although it had been eaten by the wolves, the cause of death was not evident. If the moose were not checked in some way, there is no doubt that the browse supply would be severely damaged, with a resulting reduction in moose numbers.

The Nunamiut migrate to moose country only when caribou are few, and the people are forced to kill moose in order to survive. They prefer not to live on moose meat for long periods, and I have found from personal experience that it is not nearly as satisfactory as caribou. Since most of this country is not convenient enough for sport hunting and much of it is closed by law to hunting by the white man, it would seem that the animals here should thrive as far as habitat conditions will allow and predation and disease must be depended upon for control. A. Murie (1944) has made the only well-substantiated observations on wolf–moose relationships in Alaska.

In former years moose were snared by the Eskimo. For this purpose, a line of twisted caribou hide about an inch in diameter was used.

The Nunamiut names for animals of various ages are of interest, and indicate a long familiarity with the species. Certain of these names are included here:

Nogak–calf.
Angayukliakruk–yearling.
Kiklisiksralik–young ♂ ("with horn big enough for handle of flint sharpener").
Katnautalik–2-year-old ♂ ("having fork, at tip of antler").
Atkatiksralik–3-year-old ♂ ("having antler palm shaped like mitten").
Puknik–old bull.
Kulavak–cow.

A single moose skull from Anaktuvuk Pass has been deposited in the U.S. National Museum.

Rangifer arcticus stonei Allen. *Tutu.* Stone caribou.

The caribou is one of the most frequently seen mammals of the Brooks Range country, and is the most important animal in the economy of the Nunamiut. Because of its migratory habits and the lack of accurate observations, its numerical status is highly conjectural.

The migrations of the caribou in the central Brooks Range and on the adjacent Arctic Slope are very complex, and a large number of well-integrated

observations will be required before they are understood. The general pattern of migration through the central Brooks Range, as derived from personal observation and that of the Nunamiut, is shown in Fig. 14. There is no

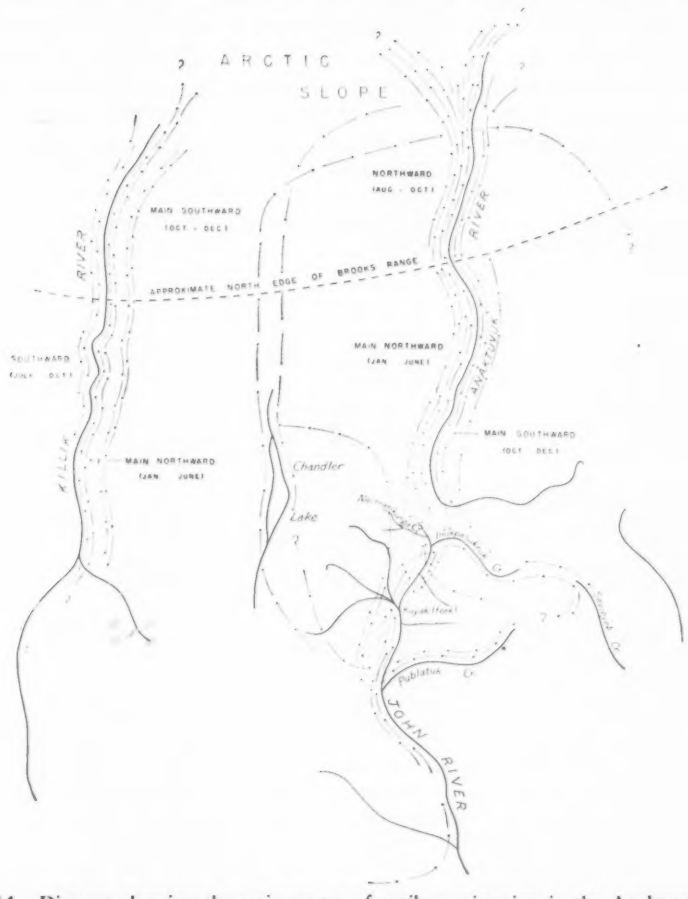

Fig. 14. Diagram showing the main routes of caribou migration in the Anaktuvuk Pass region. Other routes are used irregularly.

information, however, regarding migrations to the south and to the east, and relatively little for the Arctic Slope. Caribou movement is very erratic—a highly important factor, since the route taken may determine their exposure to hunting pressure.

In the Anaktuvuk Pass region a northward movement of caribou usually becomes apparent in January, continuing until June. The herds vary in size, from only a few animals to thousands, and movement is continually northward through the main valley. The first animals to appear are the cows accompanied by calves of the previous year. Young bulls are next in sequence, and

the old bulls, with an admixture of younger ones, come last. By April 1 the cows have ordinarily passed through to the Arctic Slope, where the calves are born.

From early June until mid-summer, caribou are usually absent from the main valley, but in early August (August 9 in 1949) a second northward migration may be seen. The herds are of mixed sex and age and are variable in size, but the majority number less than 200 animals. Few observations on herd composition were made; the following examples, however, are representative:

(1) *20 September 1949*		(2) *20 September 1949*		(3) *23 September 1949*	
Old bulls	1	Old bulls	3	Old bulls	13
Adult ♀ ♀	4	Adult ♀ ♀	5	Adult ♀ ♀	10
2-year-old ♂ ♂	2	Yearlings	2	2-year-old ♂ ♂	6
Yearling ♀ ♀	2	Calves	3	Yearling ♂ ♂ and young ♀ ♀	8
Calves	2			Calves	8
Total	11		13		45

During this movement the bulls clean the velvet from their antlers by rubbing them on willows and other small bushes.

Beginning typically in October, the entire herd comes south through the main valley. The rut occurs in mid-October, and there is much fighting among the bulls. The migration lasts well into November. However, in 1949 the southward movement did not begin until December. By January 1950 the main movement was towards the south, but on January 31 I saw a herd of from 3,000 to 4,000 animals moving to the north.

The following observations give some idea of the erratic nature of caribou movements:

In the fall of 1949 large numbers of caribou came out of Publatuk Creek from the east, and went up the main valley as far as Nachramkunga Creek, and on to the west. In December they moved in large numbers east through Inukpasukruk Creek and went over the divide into the Savioyok valley. They then apparently went on south and came back into the main valley via the Publatuk. Many re-entered the main valley just below Kalutak Creek. Some also came out along the Okoluk, and some over the high mountains near the fork called *Kayak*, at the confluence of the Kalutagiak and the John rivers. This general movement persisted until the end of April 1950, when the animals again moved northward through the main valley. The northward movement in 1950 persisted in the main valley until the end of June; after that no caribou were seen, except for a few stragglers, until late November. There were northward migrations farther to the west, however, through the valley of Chandler Lake, from the middle of August through September. Large herds were seen moving east, south of the Colville on the Arctic Slope. According to later information, it would seem that the main southward migration during the fall of 1950 took place through the Chandalar drainage. The first caribou coming south reached the divide between the two drainages on November 10, and consisted mostly of males. About 2,000 animals, mostly females, were observed at Tulugak Lake on November 20. Another herd of more than 1,000 was seen on December 5. This southward migration continued into February 1951. During March caribou came north up the John River, and some also came north out of Inukpasukruk and Nachramkunga creeks. Not many caribou were seen in the main valley in early April. On April 23 about 500 animals, mostly females, came north from Inukpasukruk Creek. From late spring until late September caribou were scarce. A few animals came from Anivik (from *aniruk*, "come out") Creek during September and

went north up the main valley. The main herd reached the divide, coming south, on 18 October 1951. At this time there was much fighting among the bulls.

Similar movements occur along the Killik River. From January through April there is usually a northward migration from the headwaters of the Noatak, to the west. In late July many animals come back into the mountains, seeking shelter from mosquitoes, according to the Eskimo. The main southward migration takes place in October, but some years it begins in September.

The Nunamiut state that the herd breaks into two main sections on the Arctic Slope, one of which goes east, eventually reaching the Arctic Coast, and the other goes west. The western segment returns to the mountains, moves southward, and finally enters the main valley, retracing its route northward during late summer. I have not been able to verify this movement, but the Eskimo consider it to be the normal pattern of migration on the Arctic Slope.

I have not so far found any evidence to support the commonly-held view that the caribou are decreasing in this region. It is possible that this is the case, but neither local knowledge nor observations by qualified persons would support such a conclusion. The Nunamiut say there has been no decrease; on the contrary, the old men say that caribou are much more numerous now than they were when they were young. This impression, of course, could readily result from a change in the migration routes.

A knowledge of the migration routes is essential for the proper management of these northern herds. If their migrations bring them into regions where they are subjected to heavy hunting pressure, measures must be taken to prevent their depletion. On the other hand, if they are relatively restricted to the central Brooks Range, where the white man does not hunt, native hunting pressure is of no importance when the yearly increment is considered.

Sex	*Age*	*Month killed*	*Weight*	*Sex*	*Age*	*Month killed*	*Weight*
♂	6 mo.	Nov.	65	♀	6 mo.	Nov.	76
♂	6 mo.	Nov.	69	♀	6 mo.	Nov.	83
♂	6 mo.	Nov.	77	♀	2 yr.	April	147
♂	6 mo.	Nov.	97	♀	2 yr.	April	148
♂	6 mo.	Nov.	117	♀	3 yr.	Nov.	150
♂	1 yr.	Dec.	140	♀	4 yr.	Nov.	170
♂	1 yr.	Dec.	153	♀	4 yr.	Nov.	210
♂	1 yr.	Nov.	187	♀	5 yr.	Nov.	180
♂	2 yr.	Feb.	145	♀	7 to 8 yrs.	April	204
♂	4 yr.	Feb.	236	♀	Aged	April	215
♂	6 yr.	Feb.	281				

Table IV. Live weights of 21 Brooks Range caribou (in pounds).

An effort was made to obtain the live weights of some caribou (Table IV), since, except those given by O. J. Murie (1935), few figures are available from the literature. All weights were taken when the old bulls were thin and without antlers. A big bull in September would weigh as much as 350 pounds.

It is anticipated that observations on aging will be published separately, when adequate material has been studied.

More controversial questions concern the caribou than any other mammal of this region. The most important of these involve reindeer–caribou and

wolf–caribou relationships. One of the most salient factors in connection with any attempt at caribou management is the influence of domestic reindeer on wild caribou stock. It is obvious, from past experience, that close herding is necessary if reindeer are to be controlled. The coastal Eskimo do not seem temperamentally suited to close herding, with the result that great losses have occurred, when the unattended animals mingle with the wild caribou and migrate with them. Such losses are often attributed to wolf predation, since this is an explanation which is readily accepted, and which absolves the herder of any blame. Wolves under some conditions no doubt do destroy reindeer. However, successful herders, such as Tom Brower of Point Barrow, who follow the close-herding method, consider damage by wolves to be negligible.

The admixture of inferior reindeer bloodlines with the native caribou is serious. This has already occurred to a considerable degree, and it is hoped that proper control will be exercised if the reindeer industry is revived in Alaska. Ear-notched animals have been killed in the Anaktuvuk Pass country, and white reindeer have been seen running with the caribou. The number of unrecognized reindeer passing through could be great. Lantis (1950) has reviewed the Alaskan reindeer situation.

There is no need here for more than a few passing remarks on the wolf–caribou relationship, since it has already been discussed in detail by A. Murie (1944). One must assume that predation has a regulatory effect of great value. In my opinion, any evidence of excessive predation automatically implies either an over-abundance of the prey species, or a disproportionate number of diseased or other physically inferior animals. Otherwise the predator is essentially in equilibrium with the species preyed upon. An example is the great modification of predator–prey relationships which occurs at the times of cyclic high population density of lemmings or other small rodents (Rausch, 1950a). Unfortunately, the principles pointed out by Errington (1946) are either poorly known or little considered. Hunting pressure is obviously not a satisfactory substitute for predation; the hunter, particularly the white man, attempts to kill the best animal possible, while under natural conditions the weak, diseased, or injured animals are those which will be eliminated. This concept is essentially substantiated by the work of such outstanding biologists as A. Murie (1944), Errington (1946), Leopold (1943; 1949), and Leopold, Sowls, and Spencer (1947). Unfortunately, the often ill-advised and uninformed "sportsman" still has an unjustified influence on game-management policies.

Diseased caribou have not been observed in this region. Larval cestodes (*Taenia* spp.) are common, but probably have no detrimental effect and other parasites are few and unimportant. The natural movement of the herds prevents massive range contamination and precludes the building up of helminth infections to dangerous proportions. Infectious diseases can hardly survive in such a moving herd, since sick animals are left behind or are killed by wolves, thus preventing more than the minimum contact with healthy animals.

The heavy seasonal hunting of the Nunamiut results mainly in the killing of male animals. In the spring, hunting is begun as soon as the weather is

favourable for preparing dried meat. By this time the bulk of the female animals has already gone out to the Arctic Slope. In the fall, when the herds are mixed, the bulls are sought because of their greater fat storage, and although a special effort is made to kill cows and calves for hides used in making certain garments, only a few animals are required.

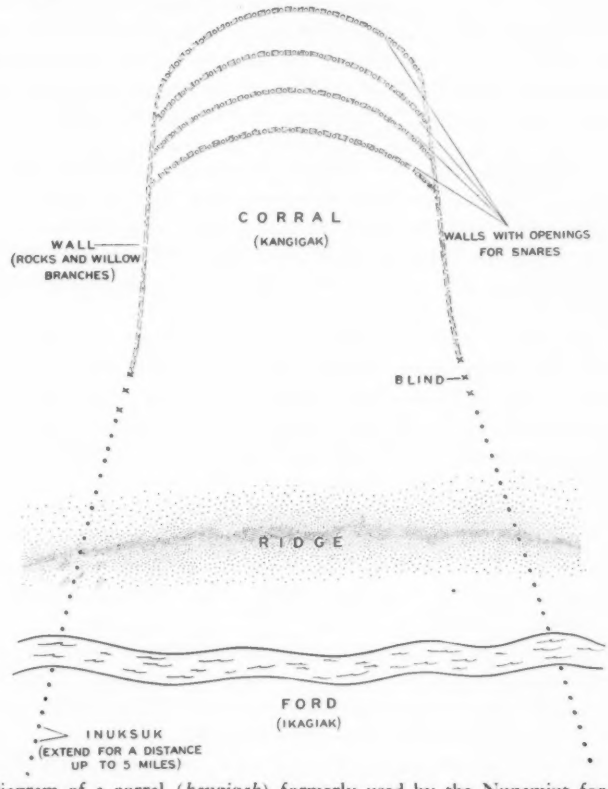

Fig. 15. Diagram of a corral (*kangigak*) formerly used by the Nunamiut for capturing caribou.

The Inland People formerly killed caribou with bows and arrows or with spears, and various methods were used to assist the hunt. One of the old methods, still employed, is to drive the caribou towards a favourable killing site by low piles of sod (*inuksuk*), placed every 50 feet or so in two converging rows. The animals fear these, and will not cross the rows under ordinary circumstances. Often a piece of caribou hide is tied to a stake placed between the piles of sod, as the fluttering of the hide in the wind adds to the effectiveness of the barrier. Sometimes the caribou are made to enter a lake, where they are speared while swimming by the men in kayaks. Killing caribou in the water with the spear is called *tutusiuvaktuat*. Caribou were formerly snared, particularly in snares set in a corral (Fig. 15). The bottom of the loop of the

snare was placed at a distance above the ground equal to the height of a man's knee plus the width of the hand with thumb extended, and the loop itself was large enough to enclose the antlers of a large bull. The corral, or *kangigak*, was constructed along a river where a low ridge prevented the caribou seeing it until too late for them to turn back, and was used year after year. It consisted of an enclosure of rocks and willow branches. The side walls were single, but the far end consisted of rows of alternate walls and openings in which the snares were set. Piles of sod diverged from the corral mouth for several miles, and the animals were driven by runners, called *tovaksiroak*. The people were careful to stay away from the front of the corral, or the caribou might detect the human scent. Once the caribou had forded the stream, they would not ordinarily return. Blinds were prepared at the mouth of the corral, and men waited in these while the drivers forced the animals over the ridge at high speed, into the mouth of the corral. The men then rushed from the blinds to close the entrance, shooting at the milling animals with the bow. Many were killed by arrows while those trying to escape through the openings of the back walls were snared.

The *kangigak* was last used about seventy-five years ago, when the parents of the men now living were young. The remains of an old corral are still visible near Tulugak Creek, just north of Tulugak Lake, and others are found on the Killik River and near Chandler Lake, such as the one at Okominilaga. Stefansson (1914, p. 385) gives a diagram of a corral similar to this, the details of which he got from a Tigiragmiut man.

The importance of the caribou to the Nunamiut is very evident. It is not surprising that three of their "moons" of the year are named for something to do with caribou. Thus, June is called *Eriknivik* ("fawning time"); September, *Amigaiksivik* ("time velvet is lost from antlers"); and October is called *Nuliakvik* ("time of rut").

Through their long dependence upon the caribou, the Nunamiut have gained a thorough understanding of its habits. These men would be of great aid as observers in any intensive study of caribou, since there is probably no white man living who knows the animal as well.

The Nunamiut names for animals of the various ages are as follows:

Nogak–calf.
Angayukliakruk–yearling ♂.
Nukatagak–young ♂.
Nukatagakruk–3-year-old ♂.
Puknikruak–4-year-old ♂.
Puknik–bull, 5 years and older.
Kulavak–cow.

Five skulls, from near Tulugak Lake, have been deposited in the U.S. National Museum.

Ovibos moschatus ?moschatus (Zimmermann). *Umiknuk* (*umik*, "beard"; *-nuk*, variant of *-puk* or *-vuk*, "big"). Muskox.

During the spring of 1951 Mr. John Krog, of the Arctic Health Research Center, picked up a badly-weathered muskox skull while making ornithological

observations near Tulugak Creek. The Eskimo readily recognized the skull, but had no knowledge of the species occurring so far to the south. None had seen the animal alive in Alaska, but they had seen hides brought in from the east, and from time to time a skull or skeleton was found on the Arctic Slope. The oldest man of the group, Ahgook, told me of having shot muskoxen near the mouth of the Coppermine River when he was a young man. He was much impressed, apparently, by having shot a bull muskox in the head, only to have the bullet deflected by the massive horn formation.

This skull will be deposited in the U.S. National Museum by Mr. Krog, who kindly gave me permission to record his finding here.

Ovis dalli dalli (Nelson). *Immaik* (*immak*, "cliff"). Dall sheep.

The Dall sheep is very common and widely distributed in the Brooks Range. Sheep do not play an important part in the economy of the Nunamiut, but they are taken from time to time when caribou are scarce.

The lambs are born in late May and early June, usually high on the mountain sides in a place safe from attack by wolves. The sheep remain high in the summer while vegetation is abundant, coming lower early in fall—as early as the end of August. In the fall and winter they are often found around the willow-grown heads of small creeks.

The rut takes place in November, and the Nunamiut name for the full moon of November is *Immait Nuliaviat* ("time of the sheep rut"). The Nunamiut say that the rams pursue their own shadows in the bright moonlight at this time; this act is called by them *tagaksiovik*. After the breeding time, the rams remain isolated from the ewes for the rest of the year, and are often seen in large flocks. Paneak told me of having seen a flock of 40 rams along the John River, but smaller groups are common. Flocks made up of rams alone occur as late as the middle of October, but by this time some are already in company with the ewes and young animals.

I have never seen large flocks of sheep, but small flocks, with a maximum number of about 20 animals, are found throughout the mountains. According to the older Eskimo, there has been no decrease in sheep numbers. The people themselves kill few sheep, since they do not consider sheep hunting worth the time and ammunition. In view of their inaccessibility and failure to grow horns of unusual size, it is unlikely that these sheep will be sought by the trophy hunter.

There is some predation on sheep by wolves and wolverine, but there is no evidence to suggest that it is ever important. Golden eagles are common, and no doubt kill a few lambs. A. Murie (1944) has given an enlightening account of sheep–wolf interrelationships.

In former days, the Nunamiut snared sheep on the mountain trails. The snare-line was attached to a buried rock, or, in some cases, particularly when there was snow, to the base of a small tree cut for the purpose, and the loop was supported by the smallest possible sticks. The distance of the bottom of the snare from the trail was equal to the height of a man's knee, and the loop was large enough to allow passage of the head of the largest ram. The

Nunamiut stated that a big ram can break a stronger snare-line than can a moose.

There has been little opportunity to obtain sheep and only 6 animals have been weighed (Table V). Some old rams probably weigh as much as 250 pounds and old barren females weigh more than the younger, breeding females. No diseased animals were seen, and no helminth parasites were found in the few animals examined. In the Brooks Range, any animals which are weakened by injury or disease will quickly be eliminated by the ever-present wolves.

Sex	*Age*	*Month killed*	*Weight*
♂	3 yr.	Oct.	122
♂	4 yr.	Feb.	110
♂	10 yr.	Feb.	153
♂	13 to 14 yrs.	Feb.	190
♀	lamb	Oct.	51
♀	adult	Oct.	115

Table V. Live weights of 6 Brooks Range sheep (in pounds).

The Nunamiut have long known how to age sheep from horn growth, but they say that they cannot be certain of accuracy after the sheep are mature (9 years, according to them). Nevertheless, A. Murie (1944) reported aging rams several years older than this, and I have found it possible to age them accurately in this manner up to at least 15 years, if the horn is sawn lengthwise. According to the Eskimo, sheep are sometimes killed which are so old that the horn points are badly worn or broken, and the horn bases are very thick and roughened. Such animals must be well over 15 years old, since I have examined heads from sheep of this age without finding unusual conditions. Data on this will be presented later if adequate material can be obtained.

The Nunamiut names for sheep of various ages are as follows:

Ivotuk–lamb.
Tamutailak–yearling ("has no teeth").
Kikiniktuligauruk–2- to 3-year-old ♂ ("smallest black horn").
Kikiniktulikrak–4-year-old ♂ ("last black colour").
Kamuyuknailak–5-year-old ♂ ("hard to drag"), or older name *Avalanarulik* ("horns more spreading").
Nikilakralik–6-year-old ♂ ("horn base size of young goose breast").
Kaumaktulik–7-year-old ♂ ("very light horn colour").
Kayutaksralik–8-year-old ♂ ("big enough for dipper", referring to dipper formerly made of ram's horn).
Angutisukruk–mature ♂ ("full grown").

Two skulls from Anaktuvuk Pass have been deposited in the U.S. National Museum. Additional material has been preserved for aging studies.

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PERMAFROST†*

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It is reported that approximately one-fifth of the land area of the earth is underlain by ground that remains frozen throughout the year (Muller, 1943 and 1945). Such frozen ground was reported by Frobisher, after his voyages to the New World in the late 16th century (Sumgin, *et al.*, 1940). Similar reports in the mid-17th century were carried to the Western World from Siberia, where remains of frozen "ice age" mammals had been discovered in remarkable states of preservation. These reports of ground frozen throughout the year, even in forested areas, were viewed with scepticism by those whose experience had not taken them from the mid-latitude temperate climates. It was not until the classic studies of Middendorff (1848-75) in Siberia, just over a century ago, that all doubts as to the existence of this seemingly strange phenomenon were dispelled.

Only casual scientific interest was taken in frozen ground until human activities in northern latitudes forced recognition of this phenomenon because of the problems it posed in the effective utilization of the land. The building of the Trans-Siberian Railroad was an important factor in the development of Russian interest in this subject. In Alaska and the Yukon Territory, the discovery of gold at the turn of the century introduced Americans to the problems of frozen ground. In 1910 a marked stimulus to the study of frozen ground and the processes resulting from intensive frost action was provided by the excursion of the 11th International Geological Congress to Spitsbergen. Members of this excursion carried home new ideas, which were used in the interpretation of Pleistocene deposits and geomorphic processes active in the rigorous climates of high altitudes (see Högbom, 1914, and others).

During the first decades of this century, Russia was the leader in the study of frozen ground. Despite the early recognition of frozen ground in Alaska and the well-known studies of Leffingwell (1919) and later Taber (1930, 1943a and b), relatively little organized effort was made toward systematic studies in this discipline. Although many scattered references to frozen ground and to the features developed by frost action can be found in reports on Alaska published during the first three decades of this century, interest was mainly directed to other seemingly more important fields, and detailed examination of frozen ground was at a minimum. With the growth of permanent settlements in Alaska, the establishment of farming communities, and the inevitable acceleration in construction of all types, the necessity for understanding and dealing with frozen ground has become of prime importance

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and concerted efforts have been made in the past ten years toward a scientific understanding and practical evaluation of this phenomenon.

Early in 1943 S. W. Muller (1943, p. 3) proposed the name *Permafrost* for "a thickness of soil or other superficial deposit, or even of bedrock, at a variable depth beneath the surface of the earth in which a temperature below freezing has existed continually for a long time (from two to tens of thousands of years)." He further stated: "Permanently frozen ground is defined exclusively on the basis of temperature, irrespective of texture, degree of induration, water content, or lithologic character." This term, around which there have been controversies, was proposed as an alternative to the expression "permanently frozen ground". However, as the ground is not *permanently* frozen, the term has been generally modified to *perennially* frozen ground. Muller distinguished a dry frozen ground, in which there was no ice as a cementing substance. This he termed "*dry permafrost*". He points out that some have applied the term perennially frozen ground to ground that contains little or no water, whereas frozen ground contains water in the form of ice. Studies have shown, however, that water is not wholly in the form of ice even though the temperature is below 0°C (Tsytovich, 1947), but that frozen and unfrozen water exist in equilibrium, their relative proportions depending on temperature, pressure, impurities, and grain size of the enclosing sediment. For simplicity, the original broad definition of Muller will be used here.

Difficulties in terminology in this field of endeavour are many. Frequently definitions have been poor, spelling casual, and duplication common because of the use of synonyms derived from the various languages in which a tremendous volume of permafrost literature is now accumulating. With this in mind, the late Kirk Bryan (1946) proposed a new terminology for this discipline which he called *Cryopedology*. Although there has been considerable resistance to the use of these new, strange, and seemingly awkward terms, there has been a gradual tendency both in North American and in foreign literature to adopt certain cryopedologic terms as substitutes for the more cumbersome phrases. It appears doubtful, however, that the term "permafrost", now so well established in both scientific and common usage, will be supplanted.

Having established just what is meant by permafrost, let us examine its character and distribution. As permafrost has a temperature of 0°C or below throughout the year, we must immediately exclude the surface layer, which thaws during the summer season. This important layer, the *active zone*, may be wholly frozen, or it may be partially or wholly thawed, depending on the season. It varies widely both laterally and vertically at any given time, depending on local conditions, and may be readily modified either by natural or by artificial means. It is this zone that is of special importance, because in it all plants are rooted and all churning and soil movements take place; it is the zone in which are developed the geomorphic features that have been considered characteristic of permafrost regions. Intensive frost action in the layer of seasonal freezing is observed outside the permafrost region; however, when this layer of seasonal freezing (the active layer) is underlain by permafrost, frost action is accelerated and intensified.

Permafrost, lying below the unstable active zone, is relatively stable under natural conditions. Its upper surface, known as the *permafrost table*, may or may not coincide with the maximum depth of the active layer. An unfrozen layer existing between the two is called *talik*, a Russian term also applied to unfrozen layers or lenses within or below the permafrost. However, in general, a seasonal decrease in temperature takes place below the active zone so that there are temperature fluctuations in perennially frozen ground below the depth of seasonal thawing (Tumel, 1940). At the borders of an area of permafrost the total thickness of maximum freezing and thawing coincide. Where maximum seasonal thawing penetrates to a depth greater than freezing, permafrost must be "degrading", or depergelating according to Bryan's terminology.

Great thicknesses of perennially frozen ground have been measured or inferred through extrapolation of thermal gradients. Freezing temperatures have been observed to depths of approximately 2,000 feet in Siberia and 1,000 feet in Alaska (Black, 1950). Is this cold reserve the result of the present climate or is it a residuum of a past and colder climate? Justification is found for each theory of origin, for at present permafrost in the Northern Hemisphere appears to be generally depergelating to the south and "aggrading", or pergelating to the north. At intermediate positions it is delicately balanced with present natural conditions, which when disturbed may cause either its disappearance or its development. Bilibin (1937) distinguished two types of permafrost, the active, which reappears when destroyed, and must therefore depend on the present climate, and the passive, which when destroyed does not reappear and thus must be a product of a colder climate. As yet much is to be learned concerning the relationship of permafrost to climate and its fluctuations. Relationship among mean annual temperatures, amount and time of precipitation in the form of rain or snow, cloudiness, evaporation, insolation, and insulation must be more thoroughly understood before they can be definitely correlated with ground conditions. Unfortunately, weather records are scanty for many areas and of too short duration to show definite trends and to permit critical comparisons based on the measured thermal regime of permafrost. At present, margins of permafrost regions are defined only by the most generalized lines on small-scale maps. The extent of permafrost in the temperate zone at high altitudes is almost unknown, especially the extent of dry permafrost. Too few holes have as yet been drilled through permafrost from which careful and detailed measurements of the thermal regime have been taken. Until more quantitative data are available, many questions will remain unsolved.

Commonly, regions of permafrost have been classified as:

1) *Continuous*, where permafrost is of wide and uninterrupted regional extent. This is generally the northernmost zone, the active permafrost of Bilibin.

2) *Discontinuous*, where there are scattered islands of *talik* within the permafrost.

3) *Sporadic*, where small islands of permafrost occur in regions of thawed ground.

Zone 3 falls within the passive permafrost of Bilibin; zone 2 is intermediate. Little is yet known about the depergelation of permafrost at its lower surface, for few observations have been made. It appears reasonable, however, to assume that under present climatic conditions there is a slow depergelation, especially in areas of passive permafrost.

During the general world-wide amelioration of climate within the past century, recorded from many diverse observations, it is probable that permafrost is shrinking in areal extent, the southern boundary moving slowly northward, as reported by Obruchev (1946) in Russia. Climatic fluctuations are known to have occurred in the past, so that features directly related to permafrost are now found far outside the limits of its present occurrence. Colder conditions will extend its occurrence. Until there is better grasp of climatic conditions and their relation to permafrost, areal expansion and contraction cannot be predicted. Such predictions would be of special value in areas of passive permafrost, where slight climatic fluctuations may cause either its complete disappearance or its regeneration.

Subfreezing winter temperatures penetrate deeply into permafrost, i.e., below the *permafrost table*, in the zone of active permafrost. Below the maximum depth of seasonal temperature fluctuations within the permafrost, the *level of zero amplitude*, the temperatures range from slightly less than zero to several degrees below zero C. For example, near Barrow, Alaska, a temperature of -9.6°C has been measured at a depth of 100 to 200 feet (Black, 1950). With increasing depth, temperatures slowly rise until 0°C is passed and permafrost disappears. In several measurements from deep wells in permafrost, reversals in temperature gradients have been noted and the conclusion has been reached that such reversals may represent past climatic fluctuations. Caution must be used in reaching such conclusions, for as Birch (1948, p. 760) points out: "The deviations from linearity of temperature–depth curves as a result of climatic fluctuations will be discernible only in unusually favorable circumstances, and it will ordinarily be advisable to examine all other disturbances before adopting a 'climatic' explanation for non-linearity." When more measurements become available, it may be possible to determine the cause of such reversals in temperature gradients, but present data are too limited for satisfactory analysis.

Ice contained in permafrost is probably its most spectacular feature. Where drainage conditions are poor and unconsolidated materials are largely fine-grained, ice masses ranging from small granules, veins, sheets, and ice wedges to large irregular masses may account for more than 50 per cent, sometimes as much as 80 per cent, of the permafrost (Taber, 1943a). This crystalline ice may range from pure to extremely impure ice, filled with air bubbles having a variety of orientations. Studies of the petrography of ground ice, recently completed at the Arctic Research Laboratory at Point Barrow, and as yet unpublished, may provide definite information concerning the origin and age of the ice. Field and laboratory studies have already indicated significant differences in physical properties of ground ice in different localities, presumably with different ages and modes of origin (Black, oral communication).

Briefly, it is apparent that permafrost is only a semi-permanent condition, relatively stable and characterized by temperatures of 0°C or below. In large part it appears to be the result of a climate colder than the present, although in the more rigorous climates it is being generated today. It has a wide areal extent, but at present appears to be depergelating along its southern margin and at an unknown rate along its lower surface. Its thickness ranges up to an observed maximum of approximately 2,000 feet. At present its areal extent, depergelation, and variations in thickness are known only from observations at widely scattered localities. Data on its thermal regime are limited. A large part of its total volume in unconsolidated sediments is of ice, which occurs in many forms, the meaning of which is at present little known. Some evidence suggests the reflection of climatic fluctuations in the thermal gradients of permafrost. It is at once apparent that relatively little is known of permafrost, despite the large volume of scientific literature.

We come to the question of the significance of perennially frozen ground in the understanding and utilization of the land that it underlies. If environmental conditions remained stable, permafrost would be stable. But environmental conditions are not stable, and the constant slight alterations of physical environment bring about changes in permafrost conditions. These changes, whether regional or local, may be produced by natural or artificial means.

One has only to observe the natural terrain in permafrost regions to see that the macro- and micro-relief differ in character from those of mid-latitude temperate climates. In order to explain this difference an entirely new series of concepts is necessary, for the classic geomorphic concepts developed by William Morris Davis and later workers for the temperate climates are not adequate. We are confronted with a terrain in which disintegration is at a maximum and decomposition at a minimum, where the surface of the ground —the active layer—undergoes rhythmic cycles of change in its physical nature. Valleys are clogged with alluvium and the distinctive slopes show a variety of relief features characteristic of mass movement as distinguished from features developed by running water. When thawing or thawed, the active layer is an unstable, water-logged mass resting on a stable permafrost substratum; drainage into the permafrost is not possible, and a complex of factors prevents ready surface drainage. Even on the most gentle slopes, thawed material rests uneasily on the frozen substratum, the contact between the two being *a glide plane* well lubricated by meltwater. Creep and viscous flow appear to be more important than gliding in downslope movement.

Fluctuations in weather conditions during any one year or climatic fluctuations over long periods may have marked significance in disturbing the thermal regime of permafrost and the active layer. With a depression of the permafrost table, for example, better drainage may be allowed the surface of the active layer, thereby changing the character of the vegetative cover and modifying the geomorphic processes that produce the micro-relief forms commonly associated with permafrost. The vegetative cover is of special importance because plants are wholly rooted in the active layer or rest upon it, and are delicate indicators of its physical condition. The vegetation acts

as an insulator for the ground, a stabilizing mat, and a trap for the accumulation and protection of snow, which is in turn an insulator of the ground. Any modification of the vegetative cover, whether through destruction by fire, uprooting by wind or frost heaving, clearing of land for cultivation or for other human activities, will directly affect both the active layer and the underlying permafrost.

When the insulating mat of vegetation is removed during the clearing of land for agricultural purposes, summer warmth penetrating the soil may depress the permafrost table, with frequently deleterious results. Ice masses in permafrost may thaw, producing a variety of topographic forms through subsidence. These range from thermokarst pits or thaw sinks (Hopkins, 1949), resulting from the thawing of large ice masses, to a hummocky micro-relief. Where wedges of ground ice arranged in polygonal patterns thaw, the enclosed ground remains as a hummock surrounded by thaw depressions. If the permafrost lacks ice masses or the ice is scattered homogeneously throughout, uniform settlement, often scarcely noticeable, takes place. Gasser (1948) states that growing tests indicate that permafrost is neither stimulating nor dwarfing to plants. Gasser (1948) and Tsiplenkin (1944) report that if the active layer is sufficiently thin, plants absorb the moisture produced by thawing of the ice at the permafrost table, obtaining necessary water where rainfall is deficient. As thawing proceeds to greater depth, drainage is increased by sinking of free water within the soil, and the surface layers in which plants are rooted may become dry so that plants will suffer if precipitation is low.

Where permafrost is continuous, supplies of ground water are difficult to obtain, for free circulating water cannot exist within it, and supplies available during thawing periods in the overlying active layer are generally unreliable. Commonly, surface water of streams and lakes is the only available supply; in winter these also may be unreliable for large and permanent supplies. However, where permafrost is discontinuous, steady supplies are frequently available from *talik* either below or within permafrost. Water derived from such thawed zones may be highly mineralized. Wells drilled through permafrost in unconsolidated material are difficult to maintain, especially where there is a high content of ice. Equally difficult is the distribution through pipes to consumers. If laid in the active layer, the pipes are subject to damage through heaving and freezing; if pipes are laid in permafrost, they are subject to freezing unless a large volume of water is kept in constant motion. Specially constructed conduits, or utilidors, and insulated pipes have been used to prevent freezing. It is readily seen that permafrost adds a difficult and complicating factor to the problems of ground-water hydrology.

The necessary disturbance of natural conditions during the construction of roads, railroads, airfields, and buildings causes a myriad of special problems. The difficulties are well known, and spectacular examples are described in the literature. Organized study of these problems has been carried on in the field and laboratory for a period of years. Whenever the natural conditions are disturbed by construction, a new set of environmental conditions is established, generally with an acceleration of frost processes that tend to establish an

equilibrium with the artificially introduced conditions. In order to adopt suitable construction methods, it is necessary to understand thoroughly the natural conditions, predict what changes will take place when they are disturbed, provide for the frost effects developed during changing of the environment, and assure a satisfactory equilibrium of the construction in the new environment that has been established. Generalizations are difficult, and it is necessary that each construction site be individually examined and interpretation made in the light of the basic data available and past experience. This is a large order, difficult to fulfil in the present state of knowledge.

The complexities of permafrost and some of its interrelations to the many facets of the environment have been briefly mentioned. Other factors are as yet little known. For example, relationship between ground ice and grain size has received attention but little has been done to indicate relationship of ground ice to shape of particles, especially as it affects the strength of the frozen material and amount of compaction when thawed and drained. Although many investigators are now engaged in research that will provide a wealth of quantitative data for the development of basic principles, the field is open to many new lines of study that will complement those of the present. Continued efforts are needed to provide the necessary data from field studies for critical analysis and prediction. The origin, extent, and physical-mechanical properties of permafrost, and its pergelation, depergelation, and relation to climate and vegetation are still only partially known. The geomorphic processes, especially those related to the active layer, deserve continuing study because of their practical significance. Only through an understanding of the basic principles can proper planning and adequate use be made of the vast areas underlain by permafrost. Man has adapted himself to a mode of life above the ground in permafrost regions, but he must adapt his activities to conditions of the ground if he is to utilize fully these northern lands.

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*The original Russian publications were not examined. The information was taken from translations and abstracts derived from various sources.

THE UPLAND PLOVER IN SOUTHWESTERN YUKON TERRITORY

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THE discovery of a breeding population of Upland Plover, *Bartramia longicauda*, in southwestern Yukon Territory in 1943 (Clarke, 1945), was of interest because there is no known breeding population between the Canadian prairie farmlands and the Yukon, and yet there is no morphological difference in the birds themselves. The existence of some northern breeding area had already been suggested by widely scattered records from Canada and Alaska (Cook, 1910; Mitchell, 1924; Rand, 1948; Taverner, 1934). I had previously studied the behaviour of the Upland Plover in Wisconsin (Buss and Hawkins, 1939) and was fortunate in being able to spend July and August 1950 making comparative studies of the same species nesting in subarctic conditions near Burwash Landing, Yukon Territory.[1]

Five pair of Upland Plover were studied intensively on a breeding ground along the Duke River, known locally as Duke Meadow, at an elevation of about 2,500 feet. One brood, consisting of two adults with four young, identified as Brood No. 3 in field notes, was located in a clearly defined area where they were seen day after day under especially favourable conditions. Incidental observations were made at two other sites in the same general area, and six pair were studied, and four adults collected, at upper timber-line between 3,000 and 4,000 feet, approximately five miles west of Burwash Landing.

The Duke River rises in the St. Elias Mountains and flows eastward to the Yukon Plateau, joining the Kluane River about five miles north of Burwash Landing. It is a turbid, swift, shallow stream that rises and falls rapidly with variations in temperature and precipitation. Like other glacial streams, it has cut numerous channels through its broad flood plain, forming constantly shifting bars and islands. Approximately three miles upstream from its confluence with the Kluane River, near the Alaska Highway, the channel has shifted to the northern edge of the valley. Along the southern bank of the river and about two feet above the present channel level is a large bar, about four miles long and nearly three-quarters of a mile wide, which is known as Duke Meadow. It is crescent-shaped and consists of sedimentary rock

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covered with a very thin layer of sandy soil with an ashy silt-like texture. The meadow is very flat, and is broken only by the slight depressions left by the former branching channels of the river.

The sparse, relatively short vegetation of Duke Meadow is dominated by six plants: (1) Bluegrass, *Poa glauca*, the most abundant species, which occurs over the entire area; (2) boreal sage, *Artemisia frigida*, nearly as abundant as bluegrass and growing over the entire area except in the bottom of some depressions; (3) and (4) pasque flower and anemone, *Anemone patens* var. *multifida* and *A. multifida*, widely distributed over the area but generally not found in the depressions; (5) milk vetch, *Astragalus alpinus*, also widely distributed and growing most abundantly in the depressions, and (6) bearberry, *Arctostaphylos Uva-ursi*, occurring as solid stands in most depressions and in mats scattered over the rest of the area.

The meadow is almost entirely edged with bush willows, *Salix glauca*, and poplars, *Populus tremuloides* and *P. balsamifera*, which encroach on it farther on the north than on the south side. Near the centre these three invaders succeed in crossing the meadow. Soapollali, *Shepherdia canadensis*, is scattered over most of the area but grows profusely only at the southern edge. The surrounding forest is mainly of white spruce, *Picea glauca*.

The native vegetation of Duke Meadow is similar to typical plover nesting cover in the midwest. Weedy plants are practically non-existent, and although shrubs and trees do occur there are large tracts entirely free of woody species. Since willow and poplars are slowly invading the area, it is apparent that the quality and capacity of Duke Meadow as an Upland Plover breeding range is slowly shrinking.

Feeding behaviour of young Upland Plover: At Duke Meadow a road meandering from the west to the east end of the area made it possible to observe plover with binoculars at close range from an automobile without alarming the birds or apparently creating unnatural behaviour. Feeding activities of young plover were observed intensively and recorded by the minute for 402 minutes on ten different occasions.

On July 4 at 7.10 p.m. two adult plover with four young (Brood No. 3) judged to be one week old were feeding near the road in the northeast part of the area. By 8.30 p.m. the family had traversed an area nearly 500 yards long. During this time the parent birds were continually visible and usually at least two of the young could be seen. The week-old plover were extremely active in their pursuit of food and at no time did a parent bird feed the young nor find food for them. Both adults caught and ate insects and one adult preened at 7.30 p.m. An adult drove off two other adult plover, which alighted close to the feeding family on two occasions, and ground squirrels, *Citellus plesius*, on three occasions. Ground squirrels were very abundant; at one time there were eleven visible in the field of the binoculars when the six plover were seen at approximately 40 yards. These squirrels appeared to cause great concern to the adult plover who did not tolerate them close to their young. At 7.55 p.m. one of the adults drove a squirrel over 25 feet before it reached the safety of a burrow. Throughout the period the adults maintained vigilant watch for enemies. Actually most of their time was spent standing quietly and erectly in the vegetation scanning the sky and nearby area for movements and signs of danger. A Sharp-shinned Hawk, *Accipter velox*, flew over the nearby woods, and

was watched quietly and without response. However, when it changed course and approached the family both adults crouched in the grass and gave a soft two-syllable call to the young who instantly "froze" low to the ground. After the hawk had passed, another two-syllable call gave the signal for feeding activities to be resumed. The young plover showed a preference for the tallest cover, most of their time being spent in the depressions, which apparently afforded the best concealment and insect food. The adults, however, preferred sparse cover and the highest sites from which the best command of the territory could be maintained, and they moved rapidly through low areas or dense vegetation. The observations of July 4 proved to be typcal except that the area covered in feeding was much less at mid-day.

By July 11 unknown mortality had reduced this family to one adult and two young. The adult was an exceptional bird, allowing an automobile to drive within 20 feet of the group without flushing or becoming excited. Thus it was easy to obtain close-range observations which proved that one of the young was larger and more aggressive than the other.

On July 13 at 1.39 p.m. the adult was seen standing guard by the two young which were resting in the grass about four feet distant. The adult chased and caught insects, preened, and teetered frequently during resting moments. By 1.59 p.m. the chicks and adult were within 12 feet of their original position. By 2.24 p.m. the adult had chattered five times, and the young had given a very low single-syllable call note three times. At 2.30 p.m. when a Goshawk, *Astur atricapillus*, flew out of the woods the adult gave a two-syllable alarm call twice (whi-whip, whi-whip) but did not move. The hawk flew along the edge of the woods and turned back into the trees. At 2.34 p.m. a Golden Eagle, *Aquila chrysaëtos canadensis*, flew out of the woods. The adult crouched quietly in the grass until the eagle flew by then stood up and ruffled its feathers. The adult did not move, but at 2.44 p.m. a chick shifted about three feet, scratched itself and sat down. At 2.54 p.m. the adult sat down, got up at 2.55 p.m. and again sat down ruffling its feathers. In two minutes it stood up and started preening, and at 2.59 p.m. it ceased preening and took three steps towards the tall grass. All three birds started moving slowly and feeding, and by 3.40 p.m. all were feeding actively and independently, having moved about 30 yards in two hours, mostly during the last half hour of observation.

The frequency of "contact talk" between young and adult Upland Plover was probably much greater than the records at Duke Meadow indicate. During numerous observations the adult's bill was seen moving, but only when either young or adult birds were close could the soft call-notes be detected.

Collectively these and other similar observations show that: (1) adult Upland Plover do not feed their young; (2) young plover range widely during active feeding time and remain within very restricted limits during resting periods; (3) adults control the movements of their young; (4) adults guard and warn their young against enemies, and (5) protective coloration provides the principal protection for both adult and juvenile plover.

Although an adult Upland Plover has never been observed brooding young, it is without doubt an important role of the parent, or parents, during cool weather, evenings, and rain-storms. Observations were purposely avoided during these times for fear of loss of chicks from unnatural exposure.

Production and mortality. One of the five pair of Upland Plover at Duke Meadow either failed to hatch its clutch, or its brood was lost at an early age. When this pair was first seen on July 2 they were quiet, flushed without

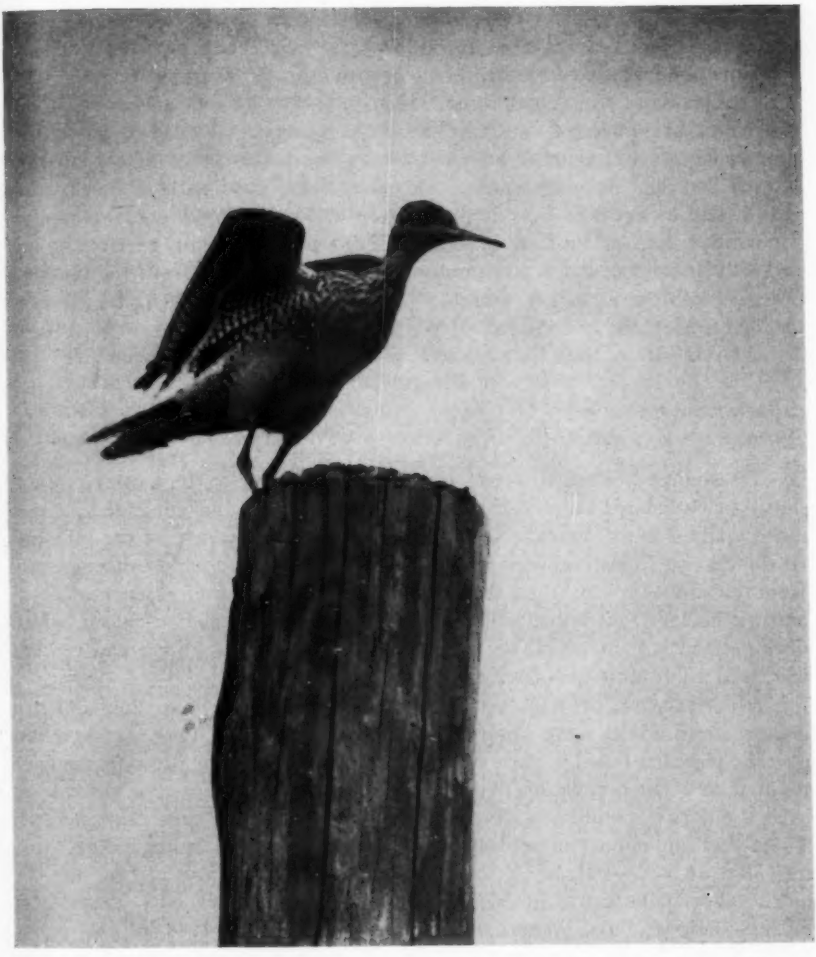

Fig. 1. Upland Plover lowering its wings in characteristic manner after alighting.

feigning injury, and showed no attachment to a particular site. They were observed three times after July 2 and consistently showed behaviour typical of birds without young. Evidently these birds started migrating southwards on July 7, on which date a pair of plover was seen perched on spruce snags near the highway about half a mile south of the study area. At no other time were plover seen at this site, and on no subsequent date were five pair seen on Duke Meadow.

One or two young from each brood were caught, banded, and examined carefully for age determination. On July 2 at 9.45 a.m. a week-old plover was banded near the centre of the area (Brood No. 1). One of the parents

had a lame right leg. At 1.20 p.m. a three-day-old plover was banded about quarter of a mile farther east (Brood No. 2). Since neither parent was lame, and since the chicks were of different age, two broods were represented. On July 4 a brood of four young observed in the northeast sector (Brood No. 3) proved to be unbanded, and on July 17 a juvenile plover was caught and banded from a brood of at least two young near the centre of the meadow (Brood No. 4). Its development indicated that it had hatched earlier than any of the other three broods; hence four different broods were accounted for by this date. The four broods consisted of a minimum of eight young (actually counted) and a maximum of sixteen as deduced from the breeding potential of four eggs per clutch (Buss and Hawkins, 1939), and were all hatched during the last eight days in June:

Brood no.	*Date first observed*	*Estimated age*	*Hatching date*
1	July 2	7 days	June 25
2	July 2	3 days	June 29
3	July 4	7 days	June 27
4	July 17	24 days	June 23

On August 1, when all young on the area were able to fly, a careful census showed two banded birds-of-the-year on the east sector, an unbanded juvenile nearby, and a fourth juvenile (also unbanded) near the centre of the meadow. At this date the juveniles were practically full-grown and could be distinguished from the adults only by their flight behaviour, bands, or the presence of down on their necks. One unbanded juvenile had a striking cinnamon colour, which distinguished it from all others. It was evident that four young had reached mature size and doubtless later migrated from the area.

After July 11, by which date Brood No. 3 had lost one adult and two young, seven adults were observed on many occasions. These seven adults plus the pair that failed in their nesting attempt and the four juvenile survivors resulted in a fall population of thirteen plover. The increase of three birds over the spring population of ten adults represents a 23 per cent increase. These data and similar unpublished data from the United States indicate that this increase is typical for Upland Plover but is much lower than rates of increase for gallinaceous birds, which show up to 81 per cent juveniles in fall populations (Buss, Meyer, and Kabat, 1951). Lack (1943, p. 215) states that: "If the British Lapwing population is stationary every 100 adults must each year produce on the average 33 young which survive to breed." Kraak, Rinkel and Hoogerheide (1940) studied the returns from 1,333 lapwings banded in Europe and calculated that 40 per cent died each year. The higher rate of increase for lapwing compared with plover in the Yukon is doubtless due to hunting pressure on the lapwing. Calculation of data presented by Drost and Hartmann (1949) on the European Oystercatcher, *Haematopus o. ostralegus*, shows an annual increase of 11 per cent for this species.

From these data, and considering clutch size, it is logical to postulate a low natural turnover rate in Upland Plover and other shore birds after they reach mature size, and a turnover rate for passerine birds (Farner, 1949) somewhere between the low rate of shore birds and the very high rate for gallinaceous birds (Leopold, Sperry, Feeney and Catenhusen, 1943).

Territory, home range, and movements. On arrival from the south most Upland Plover are paired and go directly to their nesting range. In some cases plover arriving on the same range are promptly driven away, but in other cases they are tolerated in close proximity. In southern Wisconsin I found up to eight nests per 50 acres, and their arrangement in some years suggested communal nesting. At Duke Meadow three pair nested near the centre of the area leaving the entire east half to one pair and the west quarter to a fifth pair. These data do not support either territorial or communal behaviour.

Immediately after hatching, adult Upland Plover are very much on the defensive and will drive away other plover, and in many cases other animals, that approach their young, for instance ground squirrels. There is a gradual diminution of defensive force until the young birds are able to fly. By this time families and individuals begin to mix and form flocks.

At Duke Meadow the home ranges of Upland Plover were up to two miles in diameter. Brood No. 3, however, could be found nearly every day in an area not over half a mile long and usually within one quarter of a mile in diameter. The loss of one adult and two young by July 11 did not appear to alter the size or centre of their home range, and they were frequently seen on this restricted area until July 19 when they were 22 days old. On July 22 all three birds were seen and the two juveniles were caught and banded at a point one and three-quarters of a mile southwest of their July 19 position. By July 31, when they were 34 days old, they could fly short distances and were back at their original home range in the northeast. This continued to form the centre of their range from which the birds flew more frequently until August 10, when they were last seen on Duke Meadow.

The relatively large home range of the Upland Plover is indicative of its mobility and is essential for suitable breeding or summer range. Many apparently ideal habitats within the breeding range of this species in North America are too small to be acceptable. A small grassy meadow or hayfield might suffice for a nesting site providing there is an extensive feeding and loafing area nearby. If either is missing, the range will not be occupied.

Departure from breeding ground. Evidence obtained at Duke Meadow and elsewhere in the Yukon indicates that Upland Plover depart soon after their young can fly or after their nesting attempts fail.

The pair of plover at Duke Meadow which failed in their nesting attempt left the area on July 7, while the adults and young of the other four pair were still there on July 25. On this date a flock of six plover judged to be adults flushed from the central part of the meadow. They were difficult to approach, gave both breeding and post-breeding call notes, and used long powerful wing strokes characteristic of fall behaviour. On July 31 only two full-grown juveniles were found near the centre of the meadow, but three adults and two full-grown banded juveniles were observed in the northeast sector. Two of the adults were repeatedly driven away by the third adult, which obviously was the parent of Brood No. 3. These observations suggest that four adults

had departed from the central locality, two juveniles remained on their central home ranges, and two adults had moved and attempted to flock with the family of three in the northeast. By August 5 two more adults had left. The parent of Brood No. 3 was still with its two young (banded) and all left the area on August 10 together with the other two plover-of-the-year.

These data show that: (1) the longest time any juvenile remained on the area was approximately 10 days after it began to fly; (2) adults that lost their young flocked and soon left the area, and (3) some adults departed ahead of their young. It is not known whether these were females that departed and left their young with the parent males, but the last adult seen in the Yukon with a full-grown juvenile plover proved to be a male when it was collected at timber-line on August 12. Rowan (personal communication) has found that adult female Dowitchers, *Limnodromus griseus*, desert their young, leaving them to the care of the males. Brooks (1937, p. 177) states that there is a migration of Golden Plover, *Pluvialis dominica fulva*, "down the Pacific Coast in the fall, the adults preceding the young as is usual in the Limicolae."

The direct observations of departure from Duke Meadow did not show whether this behaviour was typical for Upland Plover or whether some environmental factor hastened their departure. Examination of four adult males collected from timber-line range about four miles from Duke Meadow indicates that environment affected their physical condition and probably hastened departure. The following are some of the findings from these examinations:

Specimen	*Date collected*	*Weight in grams*	*Deposition of fat*	*Trematodes*	*Cestodes*
626	July 15	135	none	3	6
631	July 24	159	none	13	35 scolices and 20 fragments
632	July 24	154	none	10	47 scolices
649	Aug. 12	157	none	900-1000	105 scolices in 4 cm.

The data show that helminth infections increased with the advancement of the season. It is likely that the wet muskeg areas from which these birds were collected resulted in higher infections than would be found in the dry habitat more typical of plover range. The data also show that these four adults weighed from 135 to 159 grams; postmortem examinations showed no fat deposition. Upland Plover collected in southern Wisconsin at the time migration was beginning showed abundant fat stores and weighed up to 226 grams. This contrast in weight raises the questions whether optimum food conditions prevailed at Duke Meadow, and whether these food conditions were associated in any way with departure.

Since insects comprise an important part of the Upland Plover's food, weekly samples were made of insects on Duke Meadow. Three points were selected at random near the centre of the area where the home ranges of Brood Nos. 1, 2, and 4 overlapped. Fifty sweeps with a standard sweep-net were made while the sampler was walking east from point 1, fifty while walking northeast along the bottom of a depression from point 2, and fifty

while walking north from point 3. On completing fifty sweeps, the top of the net was closed and the contents were sprayed with an Aerosol Bomb to prevent small winged insects from escaping. The insects were then removed and placed in a labelled container to be counted later (see Table I).

Date	*Plot 1*	*Plot 2*	*Plot 3*	*Total*
July 4	71	34	43	148
July 11	146	122	60	328
July 18	174	115	88	377
July 25	118	171	113	402
Aug. 1	71	170	59	300
Aug. 8	46	98	16	160
Aug. 15	40	59	12	111
Aug. 22	15	17	28	60
Aug. 29	7	30	1	38
Sept. 4	1	5	3	9
Total	689	821	423	1,933

Table I. Insects collected in 1950 on Upland Plover breeding range, Yukon Territory.

Plot 1, the transect walked from point 1, yielded the most insects during the first three weeks of sampling, after which time Plot 2 produced the largest numbers. By July 25 most plants of the area were beginning to dry up, and the dense stand of *Astragalus* in the depression of Plot 2 was the most attractive place for insects. Plot 3 was consistently the lowest producer. It is considered that the samples are a good indication of the insect population trend in the area since the numbers of each plot rose and fell together, and when a species was abundant on one plot it was invariably abundant on the others.

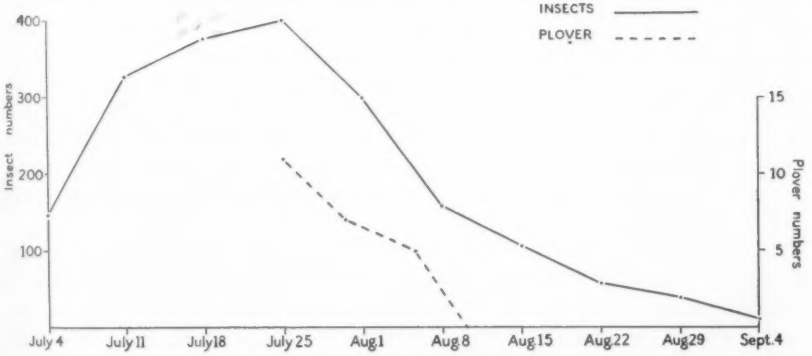

Fig. 2. Insects collected in 1950 on Upland Plover breeding range, Yukon Territory.

The weekly totals shown in Table I are presented graphically in Fig. 2, which also shows when plover left the area. Figure 2 indicates that numbers of insects and plover both declined after July 25, and that a direct correlation existed between decreasing insect numbers and plover migration. It is probable that this correlation is significant since it parallels the data on physical condition, and it has been found that Upland Plover seek good feeding areas during their late summer and early fall migration (Bates, 1907).

Observations on plover in other Yukon areas. Upland Plover were seen in two other localities at elevations of about 2,500 feet near Duke Meadow. A very small colony was recorded on the flood plain of the Donjek River about six miles upstream from the Alaska Highway. This site is similar to Duke Meadow except that it lacks good stands of bluegrass. Plover have been seen at this place in other years, and they doubtless nest here regularly.

The second recorded site below timber-line was near the Alaska Highway about eight miles southeast of Donjek River Bridge No. 1. The habitat in which these birds were seen should unquestionably be classed as Sharp-tailed Grouse, *Pedioecetes phasianellus caurus*, range, and was the most incongruous surroundings imaginable for Upland Plover. Fifteen years ago this part of the valley was a nearly solid stand of white spruce averaging between twenty and thirty feet in height. In 1937 fire swept the area, leaving snags and naked spruce skeletons standing or prostrate with shallow roots heaved skyward. Fireweed, *Epilobium angustifolium*, now grows profusely throughout the charred "jungle", with occasional patches of other weeds, shrubs, and grass. On July 26, when a pair of Upland Plover was seen at this site, both birds called excitedly, feigned injury, and returned repeatedly to the same locality where they apparently had young. A visit to this area on July 30 yielded no further observations.

Unquestionably there are small colonies of plover scattered widely over the Yukon plateau at lake and stream levels, but the total number of plover in these colonies is small compared with those living at timber-line. The wet muskeg habitat sprinkled with dwarf spruce, willow, and bog birch, *Betula glandulosa*, at upper timber-line is obviously not high quality plover range. The lower limit of occupation is probably governed by the density of trees, but the causes determining the upper limit are not so apparent. The decrease of willow and bog birch, and the better drainage with increasing elevation appear to render the higher slopes more habitable than those actually occupied. It is possible that a phenological factor governs the upper threshold of the range, such as snow, ice, or lack of vegetation at the time plover arrive in the spring. This could be determined by studies made during the spring migration and arrival period.

The use of marginal habitat in the Yukon does not alone suggest an expanding, static, or shrinking plover population. Neither does it indicate whether the species spread into this region from the south during a period of population increase, or adapted itself to a change in habitat. The unoccupied extensive prairie parklands in the Takhini–Dezadeash valley in the Yukon (Clarke, 1945) and the irregular distribution of plover in other parts of Canada where more nearly typical range exists suggest the unlikelihood of a northward spread into the Yukon. Furthermore, if the population in the Yukon were expanding it is probable that the parklands and timber-line ranges farther south would be populated by reproductive overflow. Guides who have resided in this region for many years observed plover as long ago as they can remember on timber-line ranges, but they have not noticed an increase in their numbers.

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THE PHYSICAL AND REGIONAL GEOGRAPHY OF THE U.S.S.R.

NATURAL REGIONS OF THE U.S.S.R. By L. S. Berg. *Toronto: The Macmillan Company of Canada, 1950. 9½ x 6½ inches; xxxi + 436 pages; maps, diagrams, and illustrations. $11.50.*

GEOGRAPHY OF THE U.S.S.R.; a regional survey. By Theodore Shabad. *Toronto: Oxford University Press, 1951. 9½ x 6½ inches; xxxii + 584 pages; maps and tables. $10.00.*

The Russians inhabit a vast country, the climate of which varies from arctic to subtropical, and over half of which still lies beyond the "pioneer fringe". It is not surprising that they have long taken a keen interest in the geography of their homeland. Nevertheless, in the early 'twenties of this century, most of the U.S.S.R. still awaited detailed survey. In a little more than two decades, a great deal of this work has been accomplished. By 1947 the entire country had been mapped at scales of 1:2,500,000 and 1:1,000,000, and many regions at larger scales.[1] The Russians are justly proud of the rich literature which has accumulated during this time, and much of this, unlike their maps, they have exported to the West. A number of studies are available, including texts for both primary schools and higher institutions of learning, a large number of regional geographies, and many fascinating although superficial pamphlets.

On the other hand, the scarcity of literature available in Western European languages is as striking as it is frustrating to the reader who does not command Russian. Probably only one good work was written in the inter-war years, a large volume in French by P. Calmena D'Almeida, which appeared in 1932. Even the German General Staff was compelled to prepare its own study in 1941–2; and only in 1944 did the first survey appear in English.[2] During the past six years, however, American, French, and German scholars have been busy; and each year since 1949 has seen the appearance of a major work. Two of these are English versions of important Soviet texts which have been prepared by the Russian Translation Project of the American Council of Learned Studies. The first was the 'Economic Geography of the U.S.S.R.', edited by Balzak, Vasyutin, and Feigin. To cover the physical aspect, Berg's 'Natural regions of the U.S.S.R.' was published as a companion volume last year. Together, these works, with Mr. Shabad's unusual regional survey, which was published in January 1951, will long remain standard English references.

The first edition of Professor L. S. Berg's book was published as long ago as 1930; but, although possibly superior studies have since appeared, the choice of his work by the Russian Translation Project as an authoritative and representative Soviet text on the physical geography of the U.S.S.R. is fortunate. During his long life, Berg wrote some five hundred books and monographs ranging over a dozen different aspects of his field and, long before his death a year ago, he had earned recognition as the dean of Soviet geographers. This book is to be considered as the mature fruit of a very wide scholarship. It is also an important expression of his theory of landscapes. This theory, as well as this particular book, have been used by his younger contemporaries to fabricate a Marxian "methodology" for the science of geography. The essence of Berg's approach is that the earth's surface may be divided into regions in which the interaction of all natural factors active locally produce a characteristic "landscape", and he emphasizes that this interaction, which he calls the "geographical process", is continuous. It is the study of this "process", as opposed to the mere description of "static" landscapes, that is now considered the proper task for a Soviet geography which is informed with the dialectic.

[1] *Izvestiya Akademii Nauk*, Vol. 9 (1947) pp. 373-94.

[2] Gregory, J. S., and D. W. Shave, 'The U.S.S.R., a geographical survey', 1944.

Berg's classification of the Russian countryside into eight lowland landscape-zones and twelve mountain landscapes, three of which are insular, has been substantially adopted by all Soviet geographers. Berg first defines the boundaries of each landscape, and then describes its relief, soils, and vegetation. Among the factors active in the formation of landscapes, he lists fauna (including livestock); but he remains aloof from the Soviet passion for the transformation of nature, and, in describing a country where interesting changes have been and are being wrought, he almost ignores the influence of man. Subdivisions are used to reduce the larger and more complex landscape-zones into readily intelligible units. Berg would probably not have agreed that his lowland landscapes are distinguished mainly on the basis of vegetation, although this is suggested by the nomenclature which he has adopted. Perhaps this characteristic, as well as the fact that about one quarter of the book is devoted to soils and vegetation, can be attributed to his preoccupation with the "organic" or "continuous" aspect of the geographical process.

The Russian countryside exhibits a number of peculiar features, all of which are intriguing, and some of which, in the author's view, merit brief digressions. Thus two pages dealing with the origin of the tundra landscape are appended to Chapter One; Chapter Four contains his theory of the formation of loess, as well as his explanation for the peculiar gullies of the eastern part of the European forest-steppe; and Chapter Five concludes with two pages on the problem of the vegetation of the steppe. The text contains a number of seemingly casual references to curious phenomena, such as the loessial cloud which hovers over Central Asiatic cities and the absence of glaciers in the Far Northeast, which suggest that the author was as fascinated by them as is his Western reader.

Berg's book contains undoubtedly the best simple list of the flora and fauna of the U.S.S.R. yet to appear in English. His treatment of minerals, which, for him, do not appear to enter the proper sphere of interest of the geographer, is disappointingly scanty. Other texts must be consulted for an adequate description of inland waters, climate, and geomorphological regions.

Prior to its first appearance in 1930 as the 'Landscape-geographical zones of the U.S.S.R.', much of the book had already been published in a number of monographs. The first edition was three times expanded and re-issued. It is the last edition, that of 1938, which has been chosen by the translators. In its final form it remains innocent of that turgidity from which many Russian writings suffer. Indeed, many paragraphs consist of monotonously short sentences conveying isolated facts culled from field notes as well as the immense literature available to the author. The book is gratifyingly free of those exasperating polemics which infest many Soviet economic geographies.

The translation is lucid, idiomatic, smooth, and extremely conscientious. A notable feature is the careful correlation of English and Russian names for plants and animals, the first of its kind to be done in the West. It is true that Berg's use of the taxonomic as well as of the common Russian names made such a correlation possible, but the prodigious labour which fell to the translator is evident in the bibliography which she was forced to use to complete this task. No longer can schoolmasters trip their classes up over the classic question of the translation of the Russian "kedr" as "cedar", instead of as "pine". The transliteration of several thousand place names cited in the text is not as fortunate. The translator has made too large a concession to the conventional practice of many researchers, and has developed an over-simplified system which has some four major weaknesses, largely due to the difficulty of ascertaining derivations. These have already been pointed out elsewhere by the author of the second volume reviewed in this article,[1] and need not be discussed here.

The book has been supplied with twenty-three maps, several of which appear to have been taken from other studies, including Sumgin's work on permafrost,

[1] *The American Slavic and East European Rev.*, Vol. 9 (1951) pp. 69-71.

which was presumably not available to Berg when his book was published. The author's bibliography, which was not included in a pre-war French edition, has been retained, and three large indexes covering plants, animals, and other matter mentioned in the text have been added. A glossary containing the more exotic of Russian geographical terms is valuable. There are thirty tables and eighty-one photographs, of which thirty-three have been derived from a very old German source. In a few cases, superior prints could probably have been found in modern Soviet sources.

A number of factors impel the student of Russian geography to adopt a regional approach to his subject. First, there is the obvious fact of the largeness and complexity of the country. Second, geographical studies in the U.S.S.R., both theoretical and applied, have been much exercised with the problem of regionalization; and, as the work of Soviet writers becomes better known in the West, it may be found that, in this field, they have made an interesting contribution to geographical method. Even Nazi writers have grudgingly admitted this.[1] Berg has probably contributed most towards the definition of a physical landscape-complex. Similar methods for the definition of economic and political regions have been evolved by other geographers; and, of especial significance for the foreign student, these methods are largely reflected in the economic and political regions adopted by the government for administrative and planning purposes. In the third place, the rapid industrialization of the country has caused swift and frequent changes in its economic map. These, in turn, have induced related changes in the political map. The former may be no more rapid or extensive than those shown by the nineteenth century map of the U.S.A.; but the dynamism of the Soviet political map is unparalleled elsewhere. This dynamism becomes readily intelligible only in terms of past and current developments, planned and unplanned, within each regional unit. A fourth factor lies in the explicit view of the government that a primary purpose of the whole publishing industry is to encourage the masses to ever greater efforts to build a socialist state. It is partly for this reason that many data concerning new growth have been released for smaller regions, and released through a wide variety of publications, when these are not available for the country as a whole. However incomplete, such data form a large part of the source materials available to the Western geographer. For all these reasons, he is under strong pressure to collate and present his materials by "administrative-territorial" districts of the U.S.S.R. Curiously enough, no single systematic study of all these districts is known to have been published in Russian. Mr. Shabad's book is the first thorough attempt in English at this somewhat novel presentation of Soviet geography.

Part I consists of three chapters which together make up about one-fifth of the book. These provide a background for the very detailed, regional survey which is its principal purpose. The opening chapter consists of summary accounts of the geological history and structure, relief, hydrography, climate, soils, vegetation, and mineral resources of the U.S.S.R. The next two provide highly condensed notes on the political and human geography and on the economic pattern. In this part as a whole, the author has concentrated all the more significant data, which, prior to the appearance of this book, could have been found only by a laborious search through a bewildering variety of sources, many of them obscure. The essential features of Soviet agriculture and industry are covered in only thirty pages. The treatment of "Transportation and Commerce" is less successful. Inevitably, the railways come off best; but those forms of transport which are less important in Russia (road, river, and air), are dealt with about as vaguely as these are in any one Soviet source. It is unfortunate that the whole subject of Soviet "commerce" still awaits even rudimentary treatment in English. With this exception, the "General Survey" remains probably the most serious and easily usable to be written to date.

[1]Schultz, Arved, "Bolschewistische Erdkunde", in 'Bolschewistische Wissenschaft und "Kulturpolitik"', edited by Bolko, Freiherr von Richthofen, Königsberg, 1942, pp. 111-30.

In addition to a studied brevity, Part I has the extra merit of throwing light on many of those questions which arise for the practical researcher rather than in the class room, and which remain troublesome even after much reading. A section on the administrative geography of Russia is the first analysis of its kind to appear in English, and this is probably the first book to give adequate attention to the problem of transliteration into English. The closely associated problem of Soviet place names is also dealt with. The author shows that some names are derived from local non-Slavonic languages; many are associated with the local economy; a large number are those of outstanding citizens, and others are simply Russian adjectives. He then demonstrates that changes in the grammatical form often indicate growth; that place names change as the persons for whom these are named fall into disfavour; that native names may be substituted for Russian and then be yet again replaced by Russian; and that the names of the smaller administrative-territorial units, which are generally named for their centres, may change as new centres grow up and are officially recognized. We have, then, some nine principles governing the derivation and changes in Soviet place names which greatly facilitate the comprehension and handling of these names. Moreover, the more important specific instances of name-changes are listed.

The major portion of the book is a regional survey of the U.S.S.R. The author devotes one chapter to the R.S.F.S.R., five chapters to the four republics of Central Asia, one to the Trans-Caucasian and one to the Baltic republics, and one to each of the remaining republics. It is interesting to note that, whereas regional developments in the Ukraine require only thirty pages, those in Soviet Central Asia require more than twice this space. The R.S.F.S.R. is broken down into eleven regions which are more or less the same as those distinguished by Soviet authorities. Kazakhstan is dealt with under five regional subdivisions, the Ukraine under seven. With four exceptions, the author describes each region *oblast'* by *oblast'*, in the sequence of location and importance, relief, climate, soils and vegetation, minerals, population and settlement, and administration and economy. The absence of repetition between the general descriptions of small regions and the detailed studies of these is an achievement. It is this portion of the book which will be used for reference rather than for general reading.

The Soviet government has required many years for the realization of a number of large projects. The continuity and relationship between different phases of these projects is not obvious to the casual student. Mr. Shabad's book has the merit of outlining such developments within each region. Thus the growth of the Volga–Baltic Water Route is traced until its completion in 1941 (p. 109), and the "Greater Volga" scheme is sketched on pp. 172 and 174. Having sorted a pattern out of past changes, which include those effected during the Fourth (post-war) Five Year Plan, the author occasionally indicates future changes which are still intended by the government. In this respect, he may at times accept more than is justified by the available evidence, as in the case of the Northwest Metallurgical Combine (pp. 159, 160). Similarly, he is probably the first authority to accept the penetration of the chemical industry into the Kol'skiy Poluostrov (p. 163). His attempt to estimate the population of each administrative-territorial division from electoral lists is the first to become available in any language known to the reviewer. While his results are undoubtedly representative, these are probably too high for some units which lie north of 60 degrees North. It is disappointing that he has ignored the question of forced labour, on which a considerable body of evidence must now be available. The maps have the especial merit of representing each region as it appears after all the difficulties of toponymy and of the location and size of settlements have been sifted out.

Together, Berg and Shabad provide the most detailed and authoritative references on the physical and economic geography of the Soviet North yet available in English.

C. J. WEBSTER

THE BIRDS OF GREENLAND

GRØNLANDS FUGLE: THE BIRDS OF GREENLAND. By FINN SALOMONSEN, with illustrations by GITZ-JOHANSEN. *Copenhagen: Ejnar Munksgaard, 1950 and 1951. With parallel texts in Danish and English. 13 inches x 9 inches. Part I, pp. 1-158, 17 coloured plates, and line drawings; $9.00. Part II, pp. 159-348, 19 coloured plates, and line drawings; $9.00.*

Over fifty years have elapsed since the publication of H. Winge's 'Grønlands Fugle',[1] the last comprehensive work on the avifauna of Greenland. Much has been learned in those fifty years about the birdlife of the world's largest island—information gathered almost exclusively by Danish ornithologists and published in Danish journals. Since the avifauna of Greenland falls within the scope of the American Ornithologists' Union Check-list, it is gratifying that the new 'Grønlands Fugle' should be written in both English and Danish, and further that Dr. Finn Salomonsen, an ornithologist of repute on both sides of the Atlantic, should be the author.

The present work, to be completed in three volumes, the first two of which are to hand, will be printed in an edition of 1,850 copies and will be the sole impression. Published with the support of the Danish Government, 'Grønlands Fugle' is a beautiful example of the bookmaker's art. Although paper-bound, the format is large, and the fine heavy paper and artistic type-faces used throughout leave little to be desired. The coloured plates, which will number fifty-two in all, are well reproduced in six-colour offset process.

Judging from the contents of Parts I and II, it would be difficult to imagine a publication better suited to satisfy the requirements of the American ornithologist for a reference book on the birds of Greenland. A quotation from the introduction will serve to show the scope of the volumes and the scientific caution of the author: "In the present work it is intended to deal with the breeding-birds and regular visitors only. The large number of species occurring as casual visitors in Greenland will not be described; they are, however, enumerated in a nominal list at the back of the book, followed by a bibliography. I have endeavoured to give as full an account as possible of the occurrence of the various species in Greenland, their life-habits, and taxonomy. The notes refer exclusively to conditions in Greenland; if certain facts are unknown in Greenland they are not dealt with although they may be well-known in other countries." It is regrettable that this wise procedure is not always followed by zoologists when listing animals of a given area.

Part I begins with a brief preface by Hans Hedtoft, the Danish Prime Minister. This is followed by an introduction by the author, which deals, all too briefly with past ornithological history and the zoogeography of Greenland. My most serious criticism of the work is that this fascinating section was not greatly expanded and treated in fuller detail.

The systematic list of birds follows, and twenty-two species, embracing the loons, shearwaters, petrels, swans, ducks, geese, and cormorants are described. In concise yet readable style the author presents what is known of the taxonomy, migrations, habitat preferences, food, plumages, and behaviour of each species. Interesting data are given on the number of birds in the various colonies and percentages of birds killed as determined by banding returns. Authority for records is given in the text and there are numerous footnotes commenting on certain occurrences.

Part II continues the list of birds which constitute important elements of the Greenland fauna, and ptarmigan, plover, sandpipers, phalaropes, jaegers, gulls, and terns are dealt with.

[1] *Medd. om Grønland*, Vol. 21 (1898).

The author's opinion on a number of taxonomic problems of interest to American systematists is valuable. He recognizes Løppenthin's proposed pale American race of the Long-tailed Jaeger, *Stercorarius longicauda pallescens*, as valid, a conclusion borne out by material in the Royal Ontario Museum of Zoology. The Spitsbergen form of the Red Phalarope, *Phalaropus fulicarius jourdaini* Iredale, is shown to be invalid. The specimens on which this form was based were birds collected after the natural processes of wear and fading had modified their appearance.

It is natural that, working with different collections, accumulated at different seasons and from different localities, there should be some conflict between European and American systematists with regard to certain species. It is my belief that few Canadian workers will agree with Salomonsen's treatment of the controversial problem of Thayer's and Kumlien's gulls. But it must be admitted that with the present rather skimpy knowledge of these forms it is difficult to offer a much more satisfactory explanation. Salomonsen considers both *thayeri* and *kumlieni* as very unstable forms and that both should be united with the Iceland Gull as one species. Thayer's is considered the high-arctic representative of that species and Kumlien's as a hybrid between Thayer's and the Iceland. Canadian collections would seem to indicate that, contrary to Salomonsen's opinion, Thayer's Gull is a very stable form, showing over its range as little variation as most other species of gulls. Speculation on Kumlien's Gull would be better reserved until a comprehensive study has been made on its breeding grounds. It is, however, difficult to consider it a hybrid population between the Iceland and Thayer's gulls when it has not been demonstrated to come in contact with either during the breeding season. The only gulls I have seen with Kumlien's Gull in summer have been Herring and Glaucous gulls.

The author proposes a provocative theory concerning several species of birds that show a cline in size that is contrary to "Bergman's law" which is, stated briefly, a zoological maxim that within a given species, size increases from south to north. A notable exception to this usually reliable law has been the case of the three forms of Ringed Plover, *Charadrius hiaticula*, in which the most southerly breeding form is the largest and the most northerly, the smallest. Salomonsen shows that the small, dark, northernmost form winters in the tropics, the intermediate race in the Mediterranean, while the large British form is resident. "Selection operates in the winter-quarters", he states, "where these birds spend the largest part of the year, with the result that they will be affected in accordance with the zoogeographical rules." Other examples are cited in support of this novel explanation.

The illustrations are reproductions of water-colour paintings made in Greenland by Gitz-Johansen. The artist has portrayed his birds against the colourful landscapes of Greenland in a free and interpretive style. The resulting illustrations are bright and decorative. Only adult birds are shown, in many cases only the adult male. One feels that a treatise of the calibre of 'Grønlands Fugle' might have had added value had there been included a series of photographs of the various habitats and illustrations of some of the more obscure plumages of Greenland birds.

T. M. SHORTT

INSTITUTE NEWS

Appointment of Dr. R. C. Wallace as Executive Director

The Arctic Institute announces with great pleasure that Dr. R. C. Wallace of Kingston, Ontario, has accepted, as of 15 November 1951, the position of Executive Director. Thus Dr. Wallace becomes the chief administrative officer of the Institute, which has its main office in Montreal, and two additional offices, one in New York and one in Washington.

The position of Executive Director has been vacant since December 1950, when it was given up by Dr. A. L. Washburn on his leaving Montreal to become Director of the newly-established Washington Office. The Washington Office was opened at that time to effect closer liaison between U.S. federal agencies interested in arctic affairs and between private and quasi-federal agencies interested in arctic Academy of Sciences–National Research Council, the American Association for the Advancement of Science, the Smithsonian Institution, and the Carnegie Institution.

Some further changes in the Institute offices, and the staffs operating them, are anticipated in 1952. It is regretted that Dr. Washburn is expected to leave the Institute staff early in 1952 to accept a position with the U.S. federal government. His great interest in the Institute will continue and his valued advice will still be available.

Dr. Wallace has already made himself familiar with the administrative affairs of the Institute and has visited the three offices. He will continue to reside in Kingston but will spend substantial time in Montreal and elsewhere on Institute business. Dr. Wallace was born in the Orkney Islands in 1881, and came to Canada as a young man. As a geologist he has taken a keen interest in the northward spread of mining, and in the years 1918–21 he was Commissioner for Northern Manitoba and an advocate of the building of the Hudson Bay Railroad to Churchill. From 1928–36 he was President of the University of Alberta and from 1936 until his recent retirement from the university was Principal and Vice-Chancellor of Queen's University. Dr. Wallace was President of the Research Council of Ontario from 1948–51 and President of the Royal Society of Canada in 1940–1.

JOHN C. REED, *Chairman*

McGill University—Arctic Institute research program

The Carnegie Corporation of New York has recently awarded a Grant of $139,000, to be spread over the five years 1951–5 inclusive, for a program of northern research to be carried out by McGill University and the Montreal Office of the Institute, working together. The Grant permits the annual establishment of a Senior Research Fellowship and up to seven scholarships for graduate students. A considerable portion of the scholarship money has been set aside for field work.

The Institute has long felt that research grants for the junior graduate student were very desirable. In the past, the limited funds available have meant that the graduate student has had to compete for Institute research grants with the mature scientist. The Carnegie Grant helps to avoid this competition, and therefore assists younger men who could become experienced arctic research workers, given the necessary start.

The Institute has made all its facilities available to those receiving awards and will assist in their direction. In some cases existing facilities will have to be expanded to meet the needs of the scheme and funds have been provided for this. Part of the publication funds is allotted to *Arctic*, which will publish suitable papers resulting from the field work. The Library and Map Collection

will be enlarged, and it may be necessary to add to the available field equipment.

Part of the Grant has been specifically set aside towards the salaries of Institute officers and this has made it possible to appoint Mr. Svenn Orvig as Assistant to the Director of the Montreal Office. Mr. Orvig, a graduate of Oslo University, has recently completed his Master's Degree in Geography at McGill University, and was a member of the Baffin Expedition of 1950 organized from the headquarters of the Institute.

Mr. J. J. Teal, of Greenwich, Conn., has been appointed to the first Senior Fellowship in the program. He has recently returned from a year spent in the Scandinavian north and will be engaged in writing up the results of his studies on circumpolar cultures. The scholarships for 1951–2 have been awarded to the following students: R. L. Monahan, Seattle, Wash.; J. S. Bleakney, Wolfville, N.S.; D. J. Osborn, Laramie, Wyo.; H. D. Fisher, Kamloops, B.C.; J. D. Campbell, Hamilton, Ont., and G. C. Riley, Hudson Heights, P.Q.

The Grant also continues the previous Carnegie subsidy of the McGill Summer School of Geography, which includes a program of courses on arctic geography and related studies. The Institute has given advice on this program each year and has also permitted Mr. P. D. Baird to organize the arctic courses.

The Grant is being administered by a committee consisting of: the Principal of the University, Dr. F. C. James; the Dean of Graduate Studies, Dr. D. L. Thomson; Professors M. J. Dunbar, F. K. Hare, and E. H. Kranck, of McGill University; Dr. Jacques Rousseau, Director of the Montreal Botanical Gardens; and Mr. P. D. Baird, Director of the Montreal Office of the Institute, Secretary of the Committee.

It is hoped that important scientific results will be achieved through the joint McGill University–Arctic Institute research program and that the Carnegie Grant will enable the resources of a great University and the headquarters of the Institute to be put to full and active use in furthering arctic research.

Gifts

The Chairman and Board of Governors gratefully acknowledge the following gifts:

About 100 books and a motion picture projector from Dr. A. L. Washburn.

Colour prints of Dr. Edward Wilson's Antarctic pictures from Miss Alice Bissett.

Meeting of the American Ornithologists' Union

The American Ornithologists' Union held its sixty-ninth meeting in Montreal from October 8 to 13. The headquarters of the Institute was on the official visiting list and a distinguished company of ornithologists was welcomed there on the evening of October 9. A small exhibit of work accomplished in the ornithological field by holders of Institute grants had been arranged.

Visit of Aksel Mikkelsen

Aksel Mikkelsen, the son of the Institute's Danish Governor, Captain Ejnar Mikkelsen, arrived in Canada from Greenland towards the end of August. Mr. Mikkelsen, who is a civil engineer, spent three months visiting various engineering and building concerns across the country, which have problems similar to those encountered in Greenland. One of his chief interests is in oil, which he believes may occur in west Greenland, and accordingly he passed much of his time in Alberta and in that part of the Northwest Territories immediately to the north of this province.

Photo: John Case

Valerie and Foresta Wood on project Snow Cornice, July 1951.

Maurice King in the Institute's Norseman aircraft, Baffin Island, 1950.

OBITUARY

Foresta Hodgson Wood, Valerie Wood, Maurice King

The loss of the Institute's Norseman aircraft, piloted by Maurice King and carrying Mrs. Walter A. Wood and Valerie Wood, was mentioned in a brief notice in the last number of *Arctic*. The aircraft was taking part in the Institute's research project "Snow Cornice", when it disappeared on 27 July 1951 on a flight from the research station, in the St. Elias Mountains in the Alaska–Yukon boundary region, to the base camp at Yakutat, Alaska. Mrs. Wood's husband, Walter A. Wood, is the Director of the Institute's New York Office and leader of project Snow Cornice. In spite of an intensive search by the United States Air Force, the Royal Canadian Air Force, and other official and private groups, in which Mrs. Wood's husband and son and Mr. King's son participated, no trace of the aircraft has been found and the occupants are presumed dead.

The Arctic Institute extends its deepest sympathy to their relatives. The Institute also wishes to express its most grateful thanks to all those who took part in the search for the Norseman. The following notices are written by Dr. A. L. Washburn, Director of the Washington Office.

Foresta Hodgson Wood

Foresta Hodgson Wood, the daughter of Mrs. Balm Mann Hodgson and Caspar Wistar Hodgson, was born in San Francisco, California on 10 November 1904.

Foresta attended Horace Mann School, Scarborough School, and Stanford University. She also studied sculpture at Fontainebleau in France.

Travel and a deep guiding appreciation of the beauty of nature early became part of Foresta's life. As a child she spent some time in the Phillipine Islands, travelled in China, Korea, and Japan, and also accompanied her parents on two trips around the world. Later she spent many childhood summers on her parents ranch in the California Sierra Nevada, where she made extensive pack trips into the mountains and gained practical experience in outdoor living. Perhaps more than anything else these early pack trips were responsible for her love of the out-of-doors, and especially of mountains and wilderness.

In 1928 she met Walter A. Wood, then associated with the American Geographical Society, and two years later married him in Paris. In 1929 she made some notable climbs in the Swiss Alps, and was a member of an expedition to the mountains of Kashmir and Little Tibet that included her future husband, whom she assisted in a stereo-photogrammetric survey of the Sind–Liddar watershed.

Thus at the time of her marriage Foresta had already begun a series of exploratory travels that few men or women have equalled–travels which were undertaken not primarily in the spirit of adventure, although they often constituted adventure in the real sense of the word, but travels undertaken in partnership with her husband and in which she contributed her full share to their work. Not only did she become an indispensable member of the team in organizing and implementing field activities, but throughout she encouraged and supported her husband's endeavours.

In 1931 she was in Panama and Guatemala, assisting her husband in astronomical and survey work, and in 1932 she joined him in an ascent of Neva Toluca in Mexico. Her son was born during this year and her daughter in the following year. In the

summer of 1933, while her husband was absent on an expedition to east Greenland, she shipped as a crew member on a Finnish square-rigged grain ship.

Two years later Foresta and Walter organized and led the Wood Yukon Expedition of the American Geographical Society, on which Foresta carried out a large part of the logistical and photographic work. This expedition initiated an extensive research program in the Alaska–Yukon region, which was to be Foresta's major expeditionary contribution and accomplishment during the next sixteen years. The following summer she participated in the Second Wood Yukon Expedition, in the course of which she accompanied her husband on the first ascents of several 8,000- to 10,000-foot peaks. In 1937 the Woods temporarily left their work in the Yukon and were members of the American Museum of Natural History Expedition to the Grand Canyon, on which Foresta was again responsible for the logistical and photographic work. She also made first ascents of Shiva's Temple and Wotan's Throne. In 1937 Foresta and Walter returned to the Yukon for the third time and, in connection with the survey work of the expedition, climbed to 14,000 feet on Mount Wood, named many years before for the late Zachary Taylor Wood, Assistant Commissioner of the Royal Northwest (now Royal Canadian) Mounted Police. As a member of the Fourth Wood Yukon Expedition in 1941, she continued to carry out extensive and independent photogrammetrical surveying as well as ground and air photography, and took part in the successful climb of Mount Wood, though she herself was forced to turn back at 14,500 feet because of frozen feet. All this work was carried out in spite of the fact that she was now the mother of two children aged nine and ten.

During the War, when her husband was a civilian consultant on mountain warfare and later an Army and Air Force officer engaged in arctic problems, she contributed much to the work he was doing. During his service as Assistant Military Attaché in Ottawa, she was one of the Canadian Capital's most charming and popular hostesses and made many warm friends. Only after the War, when her husband joined the staff of the Arctic Institute as Director of its New York Office, did it again become possible for her to work with him in the field.

In 1947 she accompanied him on the first post-war venture, a two months' reconnaissance of the glaciers of the northeastern St. Elias Mountains. Then in the following year she participated in initiating the Arctic Institute's research project Snow Cornice in the same region, which involved establishing a semi-permanent glaciological research station on the upper part of the Seward Glacier among North America's highest mountains. On this and subsequent Snow Cornice expeditions (see *Arctic*, Vol. 1, pp. 107–12; Vol. 2, pp. 118–9; Vol. 4, pp. 67–9) she assumed full responsibility for logistics and carried out much of the ground photography and surveying. Her work with Snow Cornice was continued in 1949 and again in 1951. The fatal accident occurred as she and her daughter Valerie were leaving the Seward Glacier research station to return to the United States.

Thus Foresta died, as she had lived, amid the adventure and beauty of some of the world's most glorious mountain scenery that she loved so well.

Foresta's accomplishments during the Wood Yukon expeditions and her three seasons with Snow Cornice are without peer for a woman. Much of the success of the work that was carried out is directly due to her logistical and photographic contributions. Only those who have seen the expeditionary motion picture records, for which she was solely responsible, can fully appreciate her attainments as a photographer—attainments that put her in the forefront of American mountain and expeditionary photographers.

On meeting Foresta in the drawing room it was immediately obvious that she was a most gracious hostess. To the casual acquaintance it probably seemed unthinkable that such a frail-appearing person, who seemed so much at home in the social and diplomatic life of New York and Ottawa, could also be one of the world's

leading mountaineers and expeditionary workers. And yet she was not only all these things, but to an even greater degree a loving mother and wife and an indispensable helpmate to her husband.

To know Foresta was to know the real meaning of a full life and to recognize strength of character and a deep spiritual devotion to God and to fellow men.

Valerie Wood

Valerie Wood was born in Zurich, Switzerland on 14 March 1933. She attended schools in Morristown, Minneapolis, Ottawa, and New York, and graduated from Brearley School in New York in 1951.

Like her mother she grew to have a fondness and appreciation of nature and of the out-of-doors through pack trips, which she made to Jasper Park with her parents in 1946 and 1947. During the latter year she also accompanied them to the Donjek Ranges of the St. Elias Mountains in the Yukon.

Valerie participated in the Institute's research project Snow Cornice in 1949 and 1951, and in both years she was thoroughly at home and played a full part in the activities of the expedition.

Valerie was a worthy daughter of her mother and in all respects remarkably like her mother in personality, attractiveness, and meaningful friendship. The many handwritten inscriptions in her Brearley School class book stand witness to her popularity.

Valerie lived a full and happy life in spite of its brevity, and to those who knew her there may be comfort in the possibility that she may have been spared some unforeseen suffering. As it is, her memory will remain an unmarred symbol of youthful dreams, happiness, and boundless friendship and love—a symbol of everything that we hold most precious in humanity.

James Maurice King

James Maurice King was born on 17 December 1900. He learned to fly in Portland, Oregon, in the late twenties and, after a tour of barn-storming, decided to go to Alaska in the early thirties.

In Alaska Maury came into his own. During the two decades that followed he became one of the best-known and most accomplished of the Alaskan bush pilots in the tradition of such pioneers as Eielson, Crosson, Gillam, and Monson, to name a few of those who have contributed so much to the development of aviation in Alaska, and who, like Maury, have now passed on. In fact Maury represented a race that is tending to vanish and to be replaced by airline pilots, few of whom have the knowledge of the woods and experience of arctic travelling that Maury had, or can boast his practical ability under adverse conditions.

Most of Maury's early flying was done in northwestern Alaska. For a time he flew with Archie Ferguson out of Kotzebue, and became familiar with every landmark in the Colville area, Seward Peninsula, and country north to Point Barrow, under both summer and winter conditions. Subsequent experience with Wien Airways and Alaska Airlines, among others, gave him equal familiarity with other parts of Alaska. In 1941 he flew Bradford Washburn over Mount Hayes and the Alaska Range, on two extended photographic flights.

In 1948 Maury became associated with Walter and Foresta Wood in the Institute's project Snow Cornice. With a specially equipped ski-wheel Norseman aircraft, he piloted the expedition personnel and equipment between the base at Yakutat and the upper part of the Seward Glacier among the lofty St. Elias Mountains. As a result the establishment and supply of the glaciological research

station became a routine operation, except for one episode, which illustrates why the bush pilots enjoy the reputation they do and why Maury was one of their leaders.

In a landing on the Seward Glacier in 1948, snow conditions were such that, with the early experimental ski-wheel landing gear, the Norseman nosed over onto its back, fortunately without serious injury to the occupants. However, an overturned aircraft, broken wing struts, and a seriously bent propellor were a major problem as no other aircraft was readily available for rescue operations and it would have been extremely hazardous to walk out to the Alaskan coast. By an ingenious arrangement of ropes and the digging of a pit under the bent propellor, Maury managed to right the aircraft without further damage. He repaired the broken struts by bracing with two-by-four lumber, and straightened the metal propellor with jacks stressed against two-by-fours lashed to the propellor. Such was his skill that the straightened propellor was only one-sixteenth of an inch out of true. Five days after the accident Maury piloted the Norseman safely back to Yakutat for permanent repairs, having saved the expedition and salvaged an aircraft that would normally have been a total loss.

The following summer Maury was again pilot for Snow Cornice, this time with a much improved ski-wheel combination based on the previous year's experience. After two summer seasons it was very desirable to carry out winter investigations on the Seward Glacier, and early in 1950 Maury successfully flew Walter and Peter Wood up to the research station for a series of observations.

During the summer of 1950 Walter Wood loaned the Norseman to P. D. Baird, Director of the Institute's Montreal Office, for the Baffin Island Expedition. Maury was again pilot, and flew the Norseman from Alaska across southern Canada to Montreal, and then to the east coast of Baffin Island. In spite of his unfamiliarity with the country he piloted the expedition safely and cheerfully, often through difficult flying conditions involving both winter- and summer-type operations. It can truthfully be said that he was in no small measure responsible for the success of the expedition.

In 1951 Maury again carried out the flying for the fourth season of project Snow Cornice. When the fatal crash occurred he was piloting the Norseman from the Seward Glacier research station to Yakutat. What happened is not known since no trace of the aircraft has been found, but it is possible that it ran into a mountain. All those who knew Maury and his ability are confident that whatever the circumstances were he did everything that could have been done to meet the situation.

During his life Maury logged some 13,000 hours flying time, of which nearly half was on skis. Approximately 800 of these hours were spent flying for the Institute on Snow Cornice and the Baffin Expedition. Although primarily known as a bush pilot he held both multi-engine and instrument ratings and was a fully qualified airlines captain. However, Maury's fame in Alaska was also based on his reputation as a person as well as on his skill as a pilot. In supplying isolated arctic or interior posts he always remembered the extra errand that he was asked to do, frequently doing more than his share in returning with a present of fresh meat or green vegetables. He carried out many mercy flights under hazardous conditions, and his indomitable spirit is shown by the fact that when taken sick at a remote arctic post he piloted his aircraft out despite a ruptured appendix. That his eldest son Dick, who participated in the search for the Norseman, has become an outstanding Alaskan pilot counted as one of his great joys.

Maury was a decisive and extremely competent pilot, a man who worked hard, but who knew how to relax and enjoy himself, a modest person, and a loyal friend. To those who know and love the North and who appreciate the role that aircraft have played, Maury will always be particularly remembered as one of the leaders of that vanishing race to which Alaska owes so much—the bush pilot.

A. L. WASHBURN

Hans Nielsen, 1898-1951

Hans Nielsen, formerly colony manager at Thule, northwest Greenland, was killed in a traffic accident in Copenhagen on 4 September 1951.

Hans Rudolf Johannes Emil Nielsen was born in the village of Qaersut, Umanak district, west Greenland, on 19 March 1898. When he had completed his education in Denmark, his relative and close friend, Dr. Knud Rasmussen, put him in charge of the trading post at Thule, where he served for more than twenty years.

Hans Nielsen's work in Thule has been of immeasurable importance to the Eskimo population of the district. His unfailing sense of justice and fairness gave him undisputed authority both among white men and among natives. He was thereby able to keep up the morale of the Eskimo by preserving the most valuable of the old tribal customs and to enlist their full cooperation in the enforcement of the game laws, a matter of vital importance after the introduction of firearms. As long as Hans Nielsen was in Thule, the natives were spared most of the difficulties that ordinarily beset primitive people on their first contact with Western civilization.

Many Danish, American, and British expeditions, which visited Thule between the two World Wars, have enjoyed the boundless hospitality of Mr. and Mrs. Nielsen. Hans Nielsen was a practical man with a thorough knowledge of his district, and his advice has saved many an inexperienced traveller from difficulties, if not from disaster.

In 1941 Hans Nielsen left Thule to accept a position as colony manager in Egedesminde, and later moved to Godhavn. A few months before his death he had retired because of failing health and had planned to settle in Denmark.

Hans Nielsen is survived by his wife, a son and a daughter, and by his mother, who after the death of her first husband married Dr. Alfred Bertelsen, Medical Counsellor to the Greenland Administration.

J. C. Troelsen

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